NATIONAL UNIVERSITIES COMMISSION

BENCHMARK MINIMUM ACADEMIC STANDARDS FOR POSTGRADUATE PROGRAMMES IN

SCIENCES

IN

NIGERIAN UNIVERSITIES

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PREFACE

A major function of the National Universities Commission is quality assurance. The Education (National Minimum Standards and Establishment of Institution) (Act) No. 16 of 1985 as amended by National Universities Commission (Amendment) (Act) No. 49 of 1988 empowers the Commission to lay dawn minimum standards for all degrees, awards and use the same standards to accredit them. The Commission, in collaboration with the universities, developed the first set of Minimum Academic Standards for the undergraduate degree programmes under the thirteen disciplines taught in all Nigerian Universities. The documents were approved by the Federal Government in 1989 and became major reference instrument for the establishment and accreditation of all undergraduate academic programmes.

After over a decade of use, the National Universities Commission commenced the process of review of the Minimum Academic Standards in 2001. The review sought to accommodate new frontiers of knowledge in all the academic disciplines, the impact of information and communication technologies and inclusion of languages and entrepreneurial studies to ensure response to current realities, global competitiveness and relevance. The documents also enunciated the Benchmarks for Learning Outcomes and Competencies expected of the graduates, making the standards not only content-based but also result-oriented.

With the success recorded in the development and use of Benchmark Minimum Academic Standards (BMAS) for undergraduate programmes, the Commission proceeded to establish the standards for postgraduate programmes. This started with a meeting of the Provosts and Deans of Postgraduate Studies in all Nigerian Universities, in 2004. The process was followed by a Needs Assessment Survey. The purpose was to determine the Expected Learning Outcomes, Entrepreneurial Skills and Competencies in Research and Developed in the same year. The first workshop was held in 2005 to produce BMAS for Master of Business Administration (MBA); as the pilot. The final product was approved in 2006 and has since been used to accredit the MBA programmes in all universities.

The experiences encouraged the Commission to convene the next workshop to develop the BMAS documents for all the other programmes. This was towards the end of 2006 and the drafts produced were sent to all universities for their comments and inputs. The comments and inputs generated were incorporated into the draft at another workshop held in 2008. The final workshop on the production of error-free documents was convened in 2009 and 2010, when academic experts took yet another look at the documents, and any programme that was omitted was included. Finally, in 2011 the drafts were subjected to editorial scrutiny of experts so as to prepare them for printing.

Although the process had been long and arduous, the Commission is delighted to present the first set of postgraduate BMAS for all identified postgraduate programmes taught in Nigerian Universities for learning and accreditation of the programmes.

On behalf of the National Universities Commission, I wish to express sincere gratitude to all the Nigerian Universities and their staff who participated in the development of these documents.

PROFESSOR JULIUS A. OKOJIE
EXECUTIVE SECRETARY
NUC, ABUJA. November, 2011

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BENCHMARK/MINIMUM ACADEMIC STANDARDS FOR POSTGRADUATE PROGRAMMES IN SCIENCES OFFERED IN NIGERIAN UNIVERSITIES

1 GENERAL REGULATIONS

1.1 Introduction

National Universities Commission (NUC) as a regulatory agency of University Education in Nigeria has risen to the challenges of the statute governing its quality assurance mandate. After successfully establishing the BMAS for the undergraduate programmes and subsequently the accreditation of all such programmes, NUC embarked on the recently concluded accreditation of the Postgraduate programmes in Management Sciences. The success of that exercise now serves as motivation for development of BMAS for all Postgraduate Programmes in Sciences of the Nigerian Universities

The BMAS developed will serve as the foundation for the accreditation of all Postgraduate Programmes in the Sciences in Nigerian Universities.

1.2 Philosophy

Philosophy of postgraduate programmes is anchored on the unbiased and systematic observations, accurate documentation and interpretation of facts and phenomena with a view to generating a body of knowledge.

1.3 Aims and Objectives

The aims and objectives of Postgraduate programmes are:

1. To produce high level man power in the sciences through the acquisition of requisite skills and knowledge, for national development.
2. To develop in science graduates a sense of inquiry, capacity for independent research and motivation to extend the frontiers of science and technology.
3. To produce graduates who will be adequately equipped for relevance in the global knowledge economy.
4. To produce graduates who are capable of applying appropriate scientific principles for solving problems for the promotion of human well being.
5. To produce manpower with optimal competencies and skills to function effectively in the academia and the private sector.

1.4 Postgraduate Diploma Programmes

a) **Basic Admission Requirements**

The criteria for admission into the PGD programme will be as follows:

i) All candidates must have five credit passes including English, Mathematics and two other relevant science subjects at 'O' Level.

ii) Candidates with Bachelors degree from an approved university must obtain a minimum of pass degree in the relevant science discipline.

iii) Holders of HND in relevant programmes from approved institutions with a minimum of Upper Credit may also be considered for admission.

1.5 PGD Programmes

i. Brewing Science
ii. Chemistry
iii. Computer Science
iv. Environmental and Conservation Biology
v. Geology

vi. Geophysics
vii. Hydrobiology and Fisheries
viii. Industrial Chemistry
ix. Industrial Physics
x. Mathematics/Statistics
xi. Meteriology
xii. Microbiology
xiii. Mineral Science
xiv. Physics
xv. Physics and Electronics
xvi. Plant Biology
xvii. Radiation Physics
xviii. Statistics
xix. Zoology

b) **Areas of Specialization**

Postgraduate Diploma programmes can be developed in any science discipline depending on needs and demand provided the university runs undergraduate degree programmes in the area.

c) **Duration of Programme**

i) Full-time Postgraduate Diploma programme shall run for a minimum of two semesters and a maximum of four semesters.

ii) The Part-time Postgraduate Programme shall run for a minimum of four semesters and a maximum of six semesters.

d) **Requirements for Graduation**

A candidate must have fulfilled the following conditions to be awarded the Postgraduate Diploma:

A candidate must pass a minimum of 28 credit units, made up as follows:

- 15 credit units in core courses.
- 9 credit units in elective courses
- 4 compulsory credit units of Research Projects.

e) **Domain of the Programme**

The Postgraduate Programme shall be domiciled in the relevant academic department or faculty depending on the university.

f) **Student Enrolment**

Enrolment shall be subject to the carrying capacity of the Department but not more than 25% of Postgraduate enrolment of the Department.

1.6 Academic Standards

1.6.1 Academic Regulations

(i) **Academic Session**

An Academic Session consists of two semesters. Each semester normally comprises 15 weeks of teaching and two weeks for examinations.

(ii) **Modular System**

All Postgraduate Diploma Programmes shall be run on a modularized system, commonly referred to as Course Unit System. All courses should therefore be sub-divided into more or less self-sufficient and logically consistent packages that are taught within a semester and

examined at the end of that particular semester. Credit units should be attached to each course.

(iii) **Definition of Credit or Unit:**
Credit units are weights attached to a course. One credit unit is equivalent to one hour per week per semester of 15 weeks of lectures or tutorials.

1.7 Programme Requirements:

(a) **Registration Procedure**
Students shall normally complete registration for courses for the semester not later than two weeks after the start of the semester. A student may not withdraw from a course after five weeks of lectures in a given semester without permission from the Dean of Postgraduate School.

A student who withdraws after this time or who fails to seek for permission from the Dean shall be deemed to have failed that course.

A student who fails to sit for more than two courses at the end of a given semester shall be deemed to have withdrawn voluntarily from the programme.

(i) **Good Standing**
To be in good standing, a student must in each semester have a Cumulative Grade Point Average (CGPA) of not less than 3.00

(ii) **Withdrawal**
Candidates with less than 3.00 CGPA shall remain in the programme for the 1st semester but shall be withdrawn if he/she fails to attain 3.00 CGPA at the end of the second semester.

1.8 Attendance

In order to be eligible for examination in a particular course, a student shall have attended a minimum of 75% of the total periods of formal instructions delivered for the course.

1.9 Course Evaluation

In the Postgraduate Diploma Programmes, assessment of students' achievements shall be based on:

i) Course Examination
ii) Term papers/Seminars;
iii) Other assignments;

Continuous Assessment
Continuous assessment shall be done through essays, tests, term papers, tutorial exercises, quizzes and homework.

Scores from continuous assessments shall be 30% of the final marks.

1.10 Examinations, Grading Procedure & Results:

(i) **Examinations**
a) In addition to continuous assessment, final examination shall be given for every course at the end of every semester.

The total scores obtainable for every course which include continuous assessment and final examination is 100%
Continuous Assessment 30%

Final Examination	70%
Total	100%

b) Each course shall normally be completed and examined at the end of the semester in which it is offered.

(ii) **Pass Mark**

The minimum pass mark in any course shall be 50%.

(iii) **Grading System**

Grading of courses shall be done by a combination of percentage marks and letter grades translated into a graduated system of Grade Point Equivalents (GPE). For the purpose of determining a student's standing at the end of every semester, the Grade Point Average (GPA) system shall be used. The GPA is computed by dividing the total number of credit points (TCP) by the total number of units (TNU) for all the courses taken in the semester. The credit point for a course is computed by multiplying the number of units for the course by the Grade Point Equivalent of the marks scored in the course.

Each course shall be graded out of a maximum of 100 marks and assigned appropriate Grade Point Equivalent as in the following table:

Credit Units	% Scores	Letter Grades	Grade Points (GP)	Average (GPA)
Vary according to contact hours assigned to each course per week per semester, and according to load carried by students.	70 – 100	A	5	Derived by multiplying I and IV and dividing by Total Credit Units
	60 - 69	B	4	
	50 - 59	C	3	
	0 – 49	F	0	

(iv) **Presentation of Results**

Results from the Postgraduate School Board of Examiners shall be presented to Senate for approval.

(v) **Release of Results**

Results shall be released/published not later than 2 weeks after approval by the Senate.

1.11 External Examiner System

The external examiner system shall be used at the end of the Postgraduate Diploma programme to assess the courses and projects.

The project shall be subject to oral examination where the student is required to show evidence that the candidate carried out the work and had pertinent knowledge of the subject matter.

1.12 Postgraduate Diploma Classification

The determination of the Postgraduate Diploma shall be based on the Cumulative Grade Point Average (CGPA) earned at the end of the programme.

CUMULATIVE GRADE	CLASS OF DIPLOMA
4.50 – 5.00	Distinction
3.50 – 4.49	Credit
3.00 – 3.49	Pass
below 3.00	Fail

1.13 Resource Requirements For Teaching And Learning In The Programme

1.13.1 Academic Staff

i) **Teacher/Student Ratio**

The staff to student ratio for the Postgraduate Programme is 1:10 for effective teaching and learning except for Research supervision which shall be 1:5

ii) **Academic Staff Workload**

An academic staff shall carry a maximum load of 3 contact hours per week per course for lectures and tutorials.

iii) **Staffing**

There should be a minimum of 8 full time teaching staff on ground in the Department. The teaching staff should have at least an M.Sc degree with at least three years university teaching experience and a rank not lower than Lecturer II.

1.13.2 Non-Academic Staff

The services of support staff, which are indispensable in the proper running of the programme as well as for administration, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. Universities should pay attention to optimum proportioning of the non-academic staff to avoid redundancy and overstaffing.

1.13.3 Computer Literacy

With the computer age and application of Information Technology, both academic and non-academic staff should be sufficiently computer literate.

1.13.4 Academic, Physical Space And Equipment Requirements

i) **Physical Facilities**

- Laboratories, preparatory rooms, stores, workshops, dark rooms, studios and other specialized spaces should be provided.
- Computer room, including Virtual Library facilities.
- Resource rooms to enhance academic development.

ii) **Office Accommodation**

The standard space requirement as shown below shall apply.

Position/Rank	m^2
Professor's Office	18.50
Head of Department's Office	18.50
Tutorial Teaching Staff's Office	13.50
Other Teaching Staff Space	7.00
Technical Staff Space	7.00
Secretarial Space	7.00
Seminar Space/per student	1.85

iii) **Classroom Space and Examination Theatres**

- Adequate classrooms should be provided with enough chairs and tables.
- Examination halls and theatres should be provided to minimize the rate of examination malpractices.

iv) **Equipment**

For effective learning the following equipment should be provided:

- Scientific equipment for specific areas of specializations, the concept of central laboratories and shared facilities through linkages and collaboration should be encouraged.
- Computers
- Photocopying machines
- Video cameras
- Tape recorders
- Internet facilities
- Multimedia projectors

1.13.5 Library Facilities:

There should be adequate physical and Virtual library facilities. These include current journals, handbooks, textbooks, manuals and other reference materials in sufficient numbers.

1.14 Learning Outcomes For Science Programmes

Comprehensive knowledge of areas of specialization.

i) Graduates should have comprehensive knowledge of their areas of specialization, encompassing an understanding of the theoretical foundations and quantitative tools of the areas of specialization, as well as the ability to apply this knowledge to solving problems.

ii) Graduates should be able to demonstrate problem solving capacity using multidisciplinary approaches in an innovative and creative way.

iii) Graduates should display comprehensive knowledge of areas of specialization and should have acquired entrepreneurial skills for self sufficiency and also to meet the needs of the public and private sectors in Nigeria and beyond.

Problem solving capacity

Graduates should be able to demonstrate problem solving capacity through lateral, critical, innovative and creative connections among diverse fields of study in analyzing problems using multidisciplinary approaches.

Global perspective

Graduates should have a broadened perspective, based on an understanding of both the domestic and global environments.

Communication competency and information management:

i) Graduates should be able to communicate effectively in written and oral English.

Graduates should have a sound understanding of the study area demonstrated by evidence of presentation of at least a paper in National/International Conference or publication in a reputable journal.

ii) Graduates should be proficient in the application of ICT to knowledge generation as well as usage in research and other endeavours.

Social and Ethical Responsibility

i) Graduates should demonstrate ethical considerations and understand the environmental implications of their research and professional activities.

ii) Graduates should endeavour to adhere to internationally accepted norms and values with respect to unbiased observations, accurate documentation and interpretation of data, and acknowledge all sources of information.

Behavioural Skills

Graduates should understand human behaviour in organizations. They should:

- have the ability to work and interact effectively in group situations;
- be disposed to mentoring and peer review;
- to be able to appreciate constructive criticism

1.15 Academic and Professional Master's Degree Programmes

1.15.1 Basic Admission Requirements

The criteria for admission into the Masters Programme (M.Sc.) will be as follows:
All candidates must have five credit passes including English, Mathematics and two other relevant science subjects at 'O' Level.

Academic Master's Degree Programme
Academic Masters Programmes qualify candidates for higher degrees while professional programmes are terminal.

(b) Candidates with Bachelor's degrees from an approved university must obtain a minimum of second class lower division with a CGPA of 3.0/5.0 for an academic programme.

(c) Candidates with at least a third class degree or HND and university PGD with CGPA of 3.0/.5.0 may be considered for admission into academic Master's degree programmes.

Professional Masters Degree Programmes

(a) Candidates for professional Master's degree programmes must obtain a minimum of second class lower division.

(b) Candidates with university degree in third class or HND plus a university PGD at credit level pass, (i.e., CGPA of 3.0/5.0) or 50% on weighted percentage average may be considered for admission into professional Master's degree programmes.

iii) All candidates must demonstrate adequate intellectual capacity, maturity and effective decision making and problem solving potentials.

1.16 Master's Degree Programmes In Science

Masters programmes can be developed in any science discipline depending on needs and demand provided the university runs NUC approved undergraduate degree programmes in the area. However the following would serve as guide towards the development of M.Sc. degree programmes

i. Biochemistry
ii. Biology
iii. Biotechnology
iv. Botany/Plant Biology
v. Brewing Science
vi. Chemistry /Industrial Chemistry
vii. Computer Science/Information Technology
viii. Environmental/Conservation Biology
ix. Fisheries/Hydrobiology
x. Genetics
xi. Geology
xii. Geophysics
xiii. Marine Biology
xiv. Mathematics
xv. Microbiology
xvi. Physics/Applied Physics
xvii. Statistics/Operations Research
xviii. Textile Science
xix. Zoology

b) **Areas of Specialization**

Candidate can specialize in any of the areas of interest as in the approved programmes of individual universities.

c) **Expected Duration of Programme**

i) A full time Academic Master's Programme should run for a minimum of 3 semesters and a maximum of 5 semesters while a full time Professional Master's programme should also run for a minimum of 3 semesters and a maximum of 5 semesters.

ii) Part-time Academic Master's programmes should run for a minimum of 5 semesters and a maximum of 8 semesters while part time Professional Master's programme should run for a minimum of 5 semesters and a maximum of 7 semesters.

iii) For extension beyond the specified maximum period a special permission of Senate shall be required.

d) **Requirements for Graduation**

To be awarded a Master's degree candidate must pass a minimum of 30 credit units made up as follows:

- Core courses of 24 credit units, including the general courses, projects and seminars.
- Elective courses of 6 credit units
- A student shall present at least one seminar, submit and defend a Thesis proposal. A student for Professional Master's degree programme shall present a project report and a seminar which may be defended.
- A student for an Academic Master's degree programme shall carry out research in a relevant area of specialization and submit an acceptable thesis

(six credit units compulsory) which must be defended before a panel of external and internal examiners

e) **Domain of the Programme**
The Masters programme shall be domiciled in the relevant academic Department. All Masters programmes of the universities should be domiciled in the department. Non-academic institutes and units should not be permitted to run Masters programmes.

f) **Student Enrolment**
Student enrolments shall be subject to the carrying capacity of the Department.

1.16.1 Academic Standards

Academic Regulations

i) **Academic Session**
An academic session consists of two semesters. Each semester normally comprises 15 weeks of teaching and two weeks for examinations.

ii) **Modular System**
All Masters Programmes shall be run on a modularized system, commonly referred to as Course Unit System. All courses should therefore be sub-divided into more or less self-sufficient and logically consistent packages that are taught within a semester and examined at the end of that particular semester. Credit units should be attached to each course.

iii) **Definition of Credit or Unit**
Credits are units attached to a course. One credit unit is equivalent to one hour per week per semester of 15 weeks of lectures or tutorials.

1.16.2 Programme Requirements

a) **Registration Procedure**
Students shall normally complete registration for courses for the semester not later than two weeks after the start of the semester. A student may not withdraw from a course after five weeks of lectures in a given semester without permission from the Dean of Postgraduate School.

A student who withdraws after five weeks or who fails to seek for permission from the Dean of Postgraduate School shall be deemed to have failed the course.
A student who fails to sit for more than 2 courses at the end of a given semester without approval should be deemed to have withdrawn voluntarily from the programme.

i) **Good Standing**
To be in good standing, a student must in each semester have a Cumulative Grade Point Average (CGPA) of not less than 3.00

ii) **Withdrawal**
A student whose cumulative grade point average is below 3.00 at the end of two consecutive semesters shall be withdrawn from the programme.

1.16.3 Attendance

In order to be eligible for examination in a particular course, a student shall have attended a minimum of 75% of the total periods of formal instructions delivered for the course.

1.16.4 Course Evaluation

i) In the Masters programmes, assessment of students' achievements should be based on:
   i) Course Examination
   ii) Continuous assessment: Term papers/Seminars;
   iii) Other assignments.

ii) **Continuous Assessment**

Continuous assessment shall be done through essays, tests, term papers, tutorial exercises, quizzes and homeworks.

Scores from continuous assessment shall be 30% of the final marks for courses.

1.16.5 Examinations, Grading Procedure & Results

i) **Examinations**

a) In addition to continuous assessment, a final examination shall be given for every course at the end of every semester.

b) The total scores obtainable for every course shall be 100% as follows:

Continuous Assessment	30%
Final Examination	70%
Total	100%

Each course shall normally be completed and examined at the end of the semester in which it is offered.

ii) **Pass Mark**

The minimum pass mark in any course/thesis shall be 50%

iii) **Grading System**

Grading of courses shall be done by a combination of percentage marks and letter grades translated into a graduated system of Grade Point Equivalents (GPE). For the purpose of determining a student's standing at the end of every semester, the Grade Point Average (GPA) system shall be used. The GPA is computed by dividing the total number of credit points (TCP) by the total number of units (TNU) for all the courses taken in the semester. The credit point for a course is computed by multiplying the number of units for the course by the Grade Point Equivalent of the marks scored in the course.

Each course shall be graded out of a maximum of 100 marks and assigned appropriate Grade Point Equivalent as in the following table:

Credit Units	% Scores	Letter Grades	Grade Points (GP)
Vary according to contact hours assigned to each course per week per semester, and according to load carried by students.	70 – 100	A	5
	60 - 69	B	4
	50 - 59	C	3
	Below 50	F	0

(v) **Presentation of Results**

Results from the Postgraduate School's Board shall be presented to Senate for approval.

(v) **Release of Results**

Results shall be released/published not later than 2 weeks after approval by the Senate.

1.16.6 External Examiner System

The external examiner system shall be used for Masters programme to assess the courses. The Thesis for academic Masters shall be defended orally before a panel of internal and external examiners. All theses should be graded.

1.16.7 Resource Requirement For Teaching And Learning In The Programme

i) **Academic Staff**

Teacher/Student Ratio

The staff to student ratio for the Masters programme shall be 1:10 for effective teaching and learning. For supervision of project work, the ratio shall be 1:5.

Academic Staff Workload

An academic staff shall carry a work load not exceeding the maximum prescribed by NUC.

Staffing

There should be a minimum of 8 fulltime Academic staff on ground in a department. The teaching staff should have at least a Ph.D. Degree and a status not less than Lecturer grade one.

Supervision

Only holders of Ph.D. degree with a minimum of one year Postdoctoral experience shall supervise Master's thesis.

ii) **Non-Academic Staff**

The services of support staff, which are indispensable in the proper running of the programme as well as for administration, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. Universities should pay attention to optimum proportioning of the non-academic staff to avoid redundancy and overstaffing.

1.16.8 Computer Literacy

With the computer age and application of Information Technology, both academic and non-academic staff should be sufficiently computer literate.

1.16.9 Academic, Physical Space And Equipment Requirements

i) **Physical Facilities**

a) Laboratories, preparatory rooms, stores, workshop, dark rooms, studios and other specialized spaces should be provided.
b) Computer room, including Virtual Library facilities.
c) Resource rooms to enhance academic development.

ii) **Office Accommodation**

The Standard space requirement as shown below shall apply.

Position/Rank	**m^2**
Professor's Office	18.50
Head of Department's Office	18.50
Tutorial Teaching Staff's Office	13.50
Other Teaching Staff Space	7.00
Technical Staff Space	7.00
Secretarial Space	7.00
Seminar Space/per student	1.85

iii) **Classroom Space and Examination Theatres**

- Adequate classrooms should be provided with enough chairs and tables.
- Examination halls and theatres should be provided to minimize the rate of examination malpractices.

iv) **Equipment**

For effective learning the following equipment should be provided:

- Scientific equipments for specific areas of specializations: the concept of central laboratories and shared facilities through linkages and collaboration should be encouraged.
- Computers
- Photocopying Machines
- Video cameras
- Tape recorders
- Internet facilities
- Multimedia Projectors

1.16.10 Library Facilities:

There should be adequate physical and Virtual Library facilities. These include current journals, handbooks, textbooks, manuals and other reference materials in sufficient numbers.

1.16.11 Learning Outcomes For Masters Programmes

Comprehensive knowledge of areas of specialization.

i) Graduates should have comprehensive knowledge of their areas of specialization, encompassing an understanding of the theoretical foundations and quantitative tools of the areas of specialization, as well as the ability to apply this knowledge to actual problems.

ii) Graduates should be able to demonstrate problem solving capacity using multidisciplinary approaches in an innovative and creative way.

i) A gruduate should display a comprehensive knowledge of area of specialization and should have acquired entrepreneurial skills, self sufficiency and also meet the needs of public and private sectors in Nigeria and beyond.

Problem solving capacity

Graduates should be able to demonstrate problem solving capacity through lateral, critical, innovative and creative connections among diverse fields of study in analyzing problems using multidisciplinary approaches.

Global perspective

Graduates should have a broadened perspective, based on an understanding of both the domestic and global environments.

Communication competency and information management:

i) Graduates should be able to communicate effectively in written and oral English.
ii) Graduates should be proficient in the application of ICT to knowledge generation, as well as usage in research and other endeavours.

Social and Ethical Responsibility

Graduates should demonstrate ethical considerations and understand the environmentalimplications of their research and professional activities.

Graduates should endeavour to adhere to internationally accepted norms and values with respect to unbiased observations, accurate documentation and interpretation of data, and acknowledge all sources of information.

Behavioural Skills
Graduates should understand human behaviour in organizations. They should:-

- have the ability to work and interact effectively in group situations;
- be disposed to mentoring and peer review;
- to be able to appreciate constructive criticism

1.17 Doctor of Philosophy (Ph.D.) Programmes

a) **Basic Admission Requirements for Doctoral Programmes**
Candidates for Ph.D. admission must satisfy the following conditions:

i) Candidates must have five credit passes including English, Mathematics and two other relevant science subjects at 'O' Level.
ii) Candidates with Bachelors degree from an approved university must obtain a minimum of second class lower division with a CGPA of 3.0/5.0.
iii) Candidates must have Academic Master's degree in relevant areas with a CGPA of 4.0/5.0 and thesis score not lower than 60% (B).

iii) Candidates must demonstrate adequate intellectual capacity, maturity and effective decision making and problem solving potentials.

Programmes in Sciences

i. Biochemistry
ii. Biology
iii. Biotechnology
iv. Botany/Plant Biology
v. Brewing Science
vi. Chemistry /Industrial Chemistry
vii. Computer Science/Information Technology
viii. Environmental/Conservation Biology
ix. Fisheries/Hydrobiology
x. Genetics
xi. Geology
xii. Geophysics
xiii. Marine Biology

xiv. Mathematics
xv. Microbiology
xvi. Physics/Applied Physics
xvii. Statistics/Operations Research
xviii. Textile Science
xix. Zoology

b) **Areas of Specialization**
Ph.D. programmes can be developed in any science discipline depending on needs and demand provided the university runs NUC approved undergraduate degree programmes in the area.

c) **Duration of Programme**
i) A full time Doctoral programme shall run for a minimum of 6 semesters and a maximum of 8 semesters.
ii) Part-time Doctoral programmes shall run for a minimum of 8 semesters and a maximum of 10 semesters.
iii) For extension beyond the specified maximum period a special permission of Senate shall be required.

d) **Requirements for Graduation**
Doctorate (Ph.D.) programmes should primarily be by Research. However, Departmental Postgraduate Committee may prescribe some courses of not more than 12 credit units to be taken by the candidates. A Doctoral (Ph.D) Thesis of 12 credit units **MUST** be defended before a Panel of Internal and External Examiners.

- A student shall present at least two seminars, submit and defend a thesis proposal.
- A student shall carry out research in a relevant area of specialization and submit an acceptable thesis.

e) **Domain of the Programme**
The doctoral programme shall be domiciled in the relevant academic Department.

f) **Student Enrolment**
Enrolments shall be subject to the carrying capacity of the Department.

1.17.1 Academic Regulations

i) **Academic Session**
An academic session consists of two semesters. Each semester normally comprises 15 weeks of teaching and two weeks for examinations.

ii) **Modular System**
All doctoral Programmes shall be run on a modularized system, commonly referred to as Course Unit System. All courses should therefore be sub-divided into more or less self-sufficient and logically consistent packages that are taught within a semester and examined at the end of that particular semester. Credit units should be attached to each course.

iii) **Definition Of Credit Or Unit**
Credit units are weights attached to a course. One credit unit is equivalent to one hour per week per semester of 15 weeks of lectures or tutorials.

1.17.2 Programme Requirements

a) **Registration Procedure**

Students shall normally complete registration of courses for the semester not later than two weeks after the start of the semester. A student may not withdraw from a course after five weeks of lectures in a given semester without permission from the Dean of Postgraduate School.

A student who withdraws after five weeks or who fails to seek for permission from the Dean of postgraduate schools shall be deemed to have failed the course.

A student who fails to sit for more than 2 courses at the end of a given semester should be deemed to have withdrawn voluntarily from the programme.

Academic Standing

i) **Good Standing**

To be in good standing, a student must in each semester have a Cumulative Grade Point Average (CGPA) of not less than 4.00 (where applicable).

ii) **Withdrawal**

A student whose Cumulative Grade Point Average is below 4.00 at the end of two consecutive semesters shall withdraw from the programme (where applicable).

1.17.3 Attendance

Ph.D. students should interact with their supervisors all the time and the supervisors must be satisfied with the level of interaction before the student is recommended for defence.

1.17.4 Course Evaluation (Where Applicable)

i) In the doctoral programmes, assessment of students' achievements should be based on:
   i) Course Examination
   ii) Term papers/Seminars;
   iii) Other assignments;

1.17.5 Examinations, Grading Procedure & Results:

(i) **Examinations**

a) In addition to continuous assessment, final examination shall be given for every course at the end of every semester.

b) The total scores obtainable for every course shall be 100% as follows:

Continuous Assessment	30%
Final Examination	70%
Total	100%

Each course shall normally be completed and examined at the end of the semester in which it is offered.

ii) **Pass Mark**

The minimum pass mark in any course and thesis shall be 60%.

iii) **Grading System**

Grading of courses shall be done by a combination of percentage marks and letter grades translated into a graduated system of Grade Point Equivalents (GPE). For the purpose of determining a student's standing at the end of every semester, the Grade Point Average

(GPA) system shall be used. The GPA is computed by dividing the total number of credit points (TCP) by the total number of units (TNU) for all the courses taken in the semester. The credit point for a course is computed by multiplying the number of units for the course by the Grade Point Equivalent of the marks scored in the course.

Each course shall be graded out of a maximum of 100 marks and assigned appropriate Grade Point Equivalent as in the following table:

Credit Units	**Scores**	**Letter Grades**	**Grade Points (GP)**
Vary according to contact hours assigned to each course per week per semester, and according to load carried by students.	70 – 100	A	5
	60 - 69	B	4
	50 - 59	C	3
	0-49	F	0

(vi) **Presentation of Results**
Results from the Postgraduate School Board shall be presented to Senate for approval.

(v) **Release of Results**
Results shall be released/published not later than 2 weeks after approval by the Senate.

1.17.6 External Examiner System

The external examiner system shall be used at the end of the doctoral programme to assess the courses and thesis.

The thesis **must** be defended orally before a panel of internal and external examiners.

1.17.7 Resource Requirement For Teaching And Learning In The Programmes

i) **Academic Staff**
Teacher/Student Ratio
The staff to student ratio for the Ph.D. programme shall be 1:10 for effective teaching and learning.

ii) **Academic Staff Workload**
An academic staff shall carry a work load not exceeding the maximum prescribed by NUC.

Staffing
There should be a minimum of 8 full time staff on ground in a department.

Teaching And Supervision
Holders of Ph.D. Degree with a minimum Postdoctoral experience of not less than three years may teach in the Ph.D. programme.

However, only holders of Ph.D. degree of a rank not lower than Senior Lecturer may supervise a doctoral thesis. For supervision of thesis, the ratio shall be 1:5

ii) Non-Academic Staff

The services of support staff, which are indispensable in the proper running of the programme as well as for administration, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. Universities should pay attention to optimum proportioning of the non-academic staff to avoid redundancy and overstaffing.

1.17.8 Computer Literacy

With the computer age and application of information technology, both academic and non-academic staff should be sufficiently computer literate.

1.17.9 Academic, Physical Space And Equipment Requirements

i) **Physical Facilities**

a) Laboratories, preparation rooms, stores, workshop, dark rooms, studios and other specialized spaces should be provided.
b) Computer Room, including Virtual Library facilities.
c) Resource Rooms to enhance academic development.

ii) **Office Accommodation**

The standard space requirement as shown below shall apply.

Position/Rank	**m^2**
Professor's Office	18.50
Head of Department's Office	18.50
Tutorial Teaching Staff's Office	13.50
Other Teaching Staff Space	7.00
Technical Staff Space	7.00
Secretarial Space	7.00
Seminar Space/per student	1.85

iii) **Classroom Space and Examination Theatres**

- Adequate classrooms should be provided with enough chairs and tables.
- Examination halls and theatres should be provided to minimize the rate of examination malpractices.

iv) **Equipment**

For effective learning the following equipment should be provided:

- Scientific equipments for specific areas of specializations, the concept of central laboratories and shared facilities through linkages and collaboration should be encouraged.
- Computers
- Photocopying Machines
- Video cameras
- Tape recorders
- Internet and E-Mail facilities
- Multimedia Projectors
- Other specialized equipment

1.17.10 Library Facilities

There should be adequate physical and virtual library facilities. These include current journals, handbooks, textbooks, manuals and other reference materials in sufficient numbers.

1.17.11 Learning Outcomes for Doctoral Programmes

i) **Comprehensive knowledge of areas of specialization.**
Graduates should have comprehensive knowledge of their areas of specialization, encompassing an understanding of the theoretical foundations and quantitative tools of the areas of specialization, as well as the ability to apply this knowledge to actual problems.

ii) Graduates should be able to demonstrate problem solving capacity using multidisciplinary approaches in an innovative and creative way.

iii) A graduate should display a comprehensive knowledge of area of specialization and should have acquired entrepreneurial skills to equip them for self sufficiency and also meet the needs of public and private sectors in Nigeria and beyond.

Problem solving capacity
Graduates should be able to demonstrate problem solving capacity through lateral, critical, innovative and creative connections among diverse fields of study in analyzing problems using multidisciplinary approaches.

Global perspective
Graduates should have a broadened perspective, based on an understanding of both the domestic and global environments. Doctoral research should be international in outlook as indicated by publishability of research data to attract international audience.

Communication competency and information management

i) Graduates should have a sound understanding of the study area demonstrated by at least a paper published in a reputable National/International journal.

ii) Graduates should be proficient in the application of ICT to knowledge generation as well as usage in research and development.

Social and Ethical Responsibility

i) Graduates should demonstrate ethical considerations and understand the environmental implications of their research and professional activities.

ii) Graduates should endeavour to adhere to internationally accepted norms and values with respect to unbiased observations, accurate documentation and interpretation of data, and acknowledgment of all sources of information.

Behavioural Skills

Graduates should understand human behaviour in organizations. They should:-

- have the ability to work and interact effectively in group situations;
- be disposed to mentoring and peer review.
- be able to appreciate constructive criticism.

2 PROGRAMMES

2.1 General Courses

All postgraduate students (irrespective of the programme) must take Management and Entrepreneurship as well as ICT & Research Method as compulsory courses. However, any student who has taken them at a particular postgraduate level is exempted at higher levels.

SCI-801 Management and Entrepreneurship (2 Credit Units)

The course will cover business environment, general management, financial management, entrepreneurship development, feasibility studies, marketing and managerial problem solving.

SCI 802 ICT and Research Methodology (2 Credit Units)

This course should cover essentials of Spreadsheets, Internet technology, Statistical Packages, Precision and Accuracy of Estimates, Principles of Scientific Research, Concepts of Hypotheses Formulation and Testing, Organization of Research and Report Writing.

SCI 803 Emerging Technologies (2 Credit Units)

Nano technology, stretchable silicon, pervasive wireless, nuclear reprogramming, nano biomechanics, epigenetics and cognitive radio.

SCI 804 Science, Environment and Innovation (2 Credit Units)

Elements of global warming, environmental protection issues, biodiversity, pollution, species at risk, social and ethical implications of science, enterprise and productivity, intellectual property rights, private public partnership and investment.

3 BIOCHEMISTRY

Masters Degree in Biochemistry - Summary

Course code	Title	Unit	Remarks
SCI 801	Management and Entrepreneurship	2	Core
SCI 802	ICT and Research Methodology	2	Corre
BCH 801	Advanced Metabolism & Control	2	Core
Course code	**Title**	**Unit**	**Remarks**
BCH 802	Advanced Enzymology	2	Core
BCH 803	Biostatics	2	Core
BCH 804	Research Techniques in Biochemistry	2	Core
BCH 805	Nutritional Biochemistry	2	Core
BCH 806	Medical Biochemistry	3	Core
BCH 807	Molecular Biology & Biotechnology	2	Core
BCH 808	Membrane Biochemistry	2	Elective
BCH 809	Biochemical Reasoning	1	Elective
BCH 810	Immunochemistry	2	Elective
BCH 811	Xenobiochemistry & Toxicology	2	Elective
BCH 812	Bioinformatics	2	Elective
BCH 813	Industrial Biochemistry	2	Elective
BCH 814	Research Project	6	Core
BCH 815	Seminar	2	Core

3.1 Core Courses

BCH 801 Advanced Metabolism and Control (2 Credit Units)

Review of intermediary metabolism of carbohydrates, proteins, lipids and nucleic acids. Recent advances in these areas. Regulations of metabolism; enzymatic and hormonal. Neurochemistry and neurological disorders

BCH 802 Advanced Enzymology (2 Credit Units)

Classification and nomenclature of enzymes. Isolation and purification of enzymes. Specificity of enzymes action. Kinetics of single substrate enzyme catalyzed reaction. Enzyme inhibitions. Kinetics of multi-substrate enzyme-catalyzed reaction. Investigations of the structures of active site of enzymes. Applications of enzyme technology; immobilized enzymes .Use of enzymes in industries, medicine, agriculture etc . Ligand binding. Kinetics of multi-binding sites, Adair's equation. Sigmoidal kinetics and allosteric enzymes. MWC and KNF models of allosteric regulation. Sigmoidal kinetics in the absence of cooperative binding. Kinetics of fast reactions. Structure and mechanism of catalysis . Recent Advances in enzyme Technology

BCH 803 Biostatistics (2 Credit Units)

Biostatistics: Definition, scope and applications. Presentation of data. Overview of measures of central tendency. Chi square test. Scientific writing I. (a) Biostatistics; Population and sample size. Sampling distribution. Research design. Study of some classical papers for experimental design and presentation of data. Normal, Binomial and Poisson distributions. Tests of significance. Students t test. Analysis of variance (ANOVA). One way and two way ANOVA. Regression Analysis .Simple and multiple regression. Overview of non parametric tests. Statistical packages; Graphpad Instat, Minitab, SAS, Epi Info, and SPSS.

BCH 804 Research Techniques In Biochemistry (2 Credit Units)

Gradient centrifugation and ultracentrifugation, Immunochemical techniques: Radioimmunoassay and enzyme-linked immunoassay, etc
Isotopic techniques

Electrophoresis, Chromatography: Ion-exchange chromatography, gel filtration, GC, hydrophobic interaction chromatography, affinity chromatography etc.
Absorption spectrophotometry (Principles, techniques uv,vis,fluorescence) applications to macromolecular structures.

BCH 805 Nutritional Biochemistry (2 Credit Units)
Dietary essentiality of carbohydrate and lipids. Concept and biological value of proteins. Physiological function and biochemical mechanism of action of vitamins and inorganic nutrients. Metabolic interaction of nutrients. Proximate composition of foodstuff; estimation of fibre, additives, vitamins, trace minerals and amino acids.
Food sensitivity and toxicology
Biochemical assessment of nutritional status. Adaptive response to undernutrition. Alcohol, sugar and fibre nutrition, protein energy malnutrition (PEM). Micronutrients deficiency diseases.

BCH 806 Medical Biochemistry (3 Credit Units)
Biochemical concept of clinical state, metabolic derangement in diseased state e.g gout, cholera, cancer, anaemia, kwashiorkor. Biochemical basis of and lesion in genetic diseases e.g. sickle cell anaemia, etc. Case studies on metabolic defects e.g human haemoglobin and molecular diseases, e.g sickle cell anaemia. Glucose-6-phophate dehydrogenase deficiency. Disorders of carbohydrate and lipid metabolisms (Diabetes, plasma lipid and coronary heart disease, cholesterol partition in plasma lipoprotein).
Inborn errors in metabolisms
Molecular parasitology: Isolation, fractionation and culture of parasites. Comparative metabolic reactions of malarial parasite, trypanosome, and other parasites. Chemotherapy and resistance
Plasma isoenzyme profile in disease state.
Plasma protein and A/G ratio
Liver function test
Case studies on metabolic defects ;phenylketonuria, orotic aciduria and pseudohyperparathyroidism.

BCH 807 Molecular Biology and Biotechnology (2 Credit Units)
Bacterial and viral chromosomes. Bacterial plasmids. Replication, transcription and translation of prokaryotic genomes. Regulation of protein biosynthesis. Transposons as mobile genetic elements. Eukaryotic chromosome and its ultrastructural organization. DNA synthesis in eukaryotes.
Biochemical aspect of cell division, cell cloning and cell fusion. Biochemistry of growth and differentiation in eukaryotes. Principle of PCR technique. Isolation and purification of RNA and DNA. Hybridization techniques.
Recombinant DNA technology and proteomics applications (e.g, production of insulin, drugs etc).
Microarray.Genetic engineering and its social implications.

3.2 Elective Courses

BCH 808 Advanced Membrane Biochemistry (2 Credit Units)
Membrane structure and function. Membrane-linked phenomena; ion transport. Morphology of membranes. Membrane biogenesis. Membrane carbohydrates and cell surface specificity/antigenic projection. Ionophoric antibiotics. Membrane dynamics. Excitable membranes. Neurotransmitters. Membrane receptors and signaling/transduction. Photobiology. Photosynthesis and Calvin cycle. Recent advances in Membrane research, e.g. roles of liposomes etc.

BCH 809 Biochemical Reasoning (1 Credit Unit)

BCH 810 Immunochemistry (2 Credit Units)
The immune system. Structure and functions of primary and secondary lymphoid organs. Chemistry and biological properties of immunoglobulin. Antibody diversity, antigen, and the complement system. Inflammation, macrophages, leucocytes, phagocytosis. Abnormalities in the immune system; Immuno-oncology, HIV, etc. Immunochemical techniques

BCH 811 Xenobiochemistry and Toxicology (2 Credit Units)
Natural and environmental toxicants. Food toxicology and carcinogens. Detoxification of toxicants. Drug and selective toxicity. Microbial and insects metabolism of xenobiotics. Resistance to drugs and pesticides. Metabolism as a determinant of toxicity. Assessment of toxicity

BCH 812 Bioinformatics (2Credit Units)
Scripting, use of computer programme, installation of programs and navigation. Sequence BLASTING, gene sequence alignment, primer design. Phylogenetic analysis, protein alignment. Data mining.

BCH 813 Industrial Biochemistry (3 Credit Units)
The biochemical industry: an overview of manufacturing and allied industries involving biochemistry at the various operation levels (viz, R D & P, raw materials processing, production, quality control/assurance, etc). Role of biochemistry in selected manufacturing and allied industries: dairy, brewing, cosmetics, food concentrates textile, laundry, etc (use of enzymes, natural products, etc). Raw materials biochemistry: science/technology of large-scale (commercial) production of industrial enzymes, vitamins, food additives, natural products, antibiotics, etc from plants, animals and microbes for the industry; expert market, economics etc. Science/technology of food concentrates, fruit juice etc. production. Biotechnology. Industrial analytical biochemistry: quality control and assurance; the public analysts; analytical kits RD&P.

BCH 814 Research Project (6 Credit Units)
Independent research in selected areas of Biochemistry and Molecular Biology under the supervision of an academic staff. Students will be required to carry out literature survey on the topic, perform experiment and produce dissertation. The submitted project report shall be defended before a panel of internal and external examiners.

4 BIOTECHNOLOGY

Summary

Core Courses

Course Titles	Course Description	Units
SCI 801	Management and Entrepreneurship	2
SCI 802	ICT and Research Methodology	2
BTE 801	Advanced Cell Biology	2
BTE 802	Advanced molecular Biology	3
BTE 803	Bioethics	2
BTE 804	Microbial Technology	2
BTE 805	Seminars in Biotechnology	2
BTE 806	Bioinformatics	3
BTE 807	Research Techniques in Biotechnology	3
BTE 800	Research Project	6
BTE 814	Seminar	2

Elective Courses

Course Titles	Courses Description	Credit Units
BTE 808	Genetic Engineering	2
BTE 809	Biotechnology Processing	2
BTE 810	Biotechnology in Food processing	2
BTE 811	Plant Biotechnology	2
BTE 812	Animal Biotechnology	2
BTE 813	Medical Biotechnology	2

Admission Requirements

M.Sc degree programme in Biotechnology is open to candidates with B.Sc degree in Biochemistry, Microbiology, Biological Sciences, Chemical Engineering, Pharmacy, and Food Science and technology from approved universities with a minimum of Second class, lower Division. Candidates with HND certificates at the Upper Credit level or more may be considered.

4.1 Core Courses

BTE 801. Advanced Cell Biology (2 Credit Units)

Plant and animal cells. Carbohydrate , fat and protein metabolism. Concepts of DNA, RNA and proteins. Plant and animal DNA, RNA. DNA and RNA synthesis. Protein Synthesis. Genes, gene transcription and translation. Subcellular protein targeting. Protein stability and turnover. Cell death. Plant and animal hormones and Vitamins intracellular and intercellular communication. Regulation of tissue growth.

BTE 802. Advanced Molecular Biology (3 Credit Units)

Principles of gene amplification. Polymerase chain reaction. Multiplex PCR. DNA and RNA extraction and purification. Expression vectors, promoters, plasmids and clones. Principles of plasmid ligation. Restriction digestion analysis. Principles of microarray and DNA chip analysis. Sequencing. Hybridization techniques. Gene transfer methods (electroporation, protoplastfusion). Gene addition and subtraction. Gene regulation. Genetic mapping. Gene and DNA markers: Restriction fragment length polymorphism (RFLP), Short tandem repeats or microsatellites (STR), Single nucleotide polymorphism (SNP), Expressed sequence tags (EST). Genetic fingerprinting and

footprinting. Methods of DNA cloning and protein expression. DNA analysis in agriculture, medicine, forensic science and archeology.

BTE 803. Bioethics (2 Credit Units)
Environmental impact of biotechnology. Use of genetically modified organisms (GMO), earosols, insecticides, etc. Social, ethical and legal considerations. Regulation of biotechnology. Issues in biosafety. Biosafety regulations.

BTE 804. Microbial Technology (2 Credit Units)
History of microbial technology. Microbial biodiversity. Protein production by bacteria. Production of fuel alcohol, beer, wine, dairy products, etc. Biomass transformation and microbiology of pulp and paper. Polymer synthesis and biodegradation. Use of viruses in biotechnology.

BTE 805. Seminars in Biotechnology (2 Credit Units)
Designed to give practice in critical reading of research articles in journals and in the oral and visual presentation of scientific information.

BTE 806. Bioinformatics (3 Credit Units)
Scripting. Use of computer programmes. Programme installation and navigation. Data mining. Statistical analysis. Primer design. Sequence analysis. BLAST. Phylogenetic analysis. Protein alignment.

BTE 807. Research Techniques in Biotechnology (3 Credit Units)
RT-PCT. Real-Time PCR. Multiplex PCR. Vertical gel electrophoresis for proteins. Horizontal gel electrophoresis for nucleic acids. Northern and Southern blot analysis for nucleic acids. Gel-shift and gel retardation of DNA-protein complex analysis. Western blot analysis for proteins ELISA.Transformation, transfection and cloning. Rapid amplification of DNA ends (RACE). Cell and tissue culture. Mass Spectrometry (MALDI-TOF, etc.). Chromatographic analysis. Microarray and DNA chip analysis of transcriptomes and proteoms.

4.2 Elective Courses

BTE 808. Genetic Engineering (2 Credit Units)
Definition. Aims of genetic engineering. Nucleic acid structure and function. Genomic structure: genes, exons and introns. Cloning and gene therapy. Analysis of specific genes and genomes. Mutagenesis and DNA repair. Trangenesis. Use of antisense technology. Terminator technology. Production of recombinant proteins (recombinant hormones, enzymes, vaccines, etc.). Genetically modified plants and animals. Gene pharming.

BTE 809. Biotechnology Processing (2 Credit Units)
Data analysis: linear and non-linear models. Mass balance. Species mass. Microbial and cellular growth stoichiometry. Product formation, reductase balance and yield maintenance. Energy balance. Reaction kinectics and biological systems. Chemostats, batch fermentors. Immobilized enzymes and cells. Filtration, centrifugation and chromatography.

BTE 810. Biotechnology in Food Processing (2 Credit Units)
Quality and storage of specific foods. Functional foods. Microbial influence on food production and storage. Quality assurance in the industry. Biotechnology targets in food processing. Improving food quality. Genetically engineered enzymes and additives in foods. Optimization of food processing methods. Microbial biomass and indigenous fermented foods.

BTE 811. Plant Biotechnology (2 Credit Units)
Plant tissue culture and applications. Micropropagations, somatic embryogenesis, somaclonal variations. Chemicals and plants interactions. Application of genetic engineering in crop improvement, herbicide resistance, insect resistance, environmental tolerance, virus resistance, and agricultural food production.

BTE 812. Animal Biotechnology (2 Credit Units)
Gene transfer methods in animal production. Microinjection, embryonic stem cell. Transgenic animal models. Animal diseases and gene therapy. Animal propagation through artificial insemination and cloning. Dolly the Sheep. Embryo transfer. Regulation of transgenic animal production. Genetically engineered animals. Protein engineering from live animals. Risk assessment of biotechnology in animals.

BTE 813. Medical Biotechnology (2 Credit Units)
Gene therapy and gene delivery methods. Immunoenhancing technology. Nucleic acid vaccines. Therapeutic ribozymes. Synthetic drugs. Tissue engineering with reference to skin, liver, and pancreas. Xenotransplantation. Antibody engineering. Cell-adhession based therapy. Drug delivery.

5 BOTANY/ PLANT BIOLOGY

5.1 Master's Degree in Botany/Plant Biology

5.1.1 Core Courses applicable to all options

BOT 800	Seminar	(2 Credit Units)
BOT 899	Research Projects	(6 Credit Units)
SCI 802	ICT and Research Methodology	(2 Credit Units)
SCI 801	Management and Entrepreneurship	(2 Credit Units)
BOT 804	Advanced & Current Techniques in Plant breeding	(3 Credit Units)
BOT 805	Field Studies of Nigeria flora	(3 Credit Units)
BOT 806	Science, Environment and Innovation	(3 Credit Units)
BOT 811	Evolution and diversity of Major plant Groups	(3 Credit Units)

5.1.2 Elective Courses

MSc Genetics

BOT 807	Advanced Cytogenetics	(3 Credit Units)
BOT 808	Advanced Molecular Genetics	(3 Credit Units)
BOT 809	Population Genetics	(3 Credit Units)
BOT 810	Radiation Genetics in Plants	(3 Credit Units)
BOT 812	Evolutionary Mechanisms	(3 Credit Units)

Plant Physiology

BOT 814	Plant Growth Regulatory Substances	(3 Credit Units)
BOT 815	Growth and Developmental Physiology in Plants	(3 Credit Units)
BOT 816	Biological Techniques.	(3 Credit Units)
BOT 840	Nutrient Metabolism in plants	(3 Credit Units)
BOT 839	Advanced Physiology and Metabolism	(3 Credit Units)

Plant Ecology

BOT 865	Forest and Savanna Ecology	(3 Credit Units)
BOT 817	Techniques in Plant Ecology	(3 Credit Units)
BOT 818	Ecosystems Pollution Ecology	(3 Credit Units)
BOT 819	Physiological Plant Ecology	(3 Credit Units)
BOT 820	Air Pollution and plant degradation.	(3 Credit Units)
BOT 821	Production Ecology	(3 Credit Units)
BOT 846	Weed Biology.	(3 Credit Units)
BOT 847	Ecology of Aquatic Macrophytes	(3 Credit Units)
BOT 844	Biogeography	(3 Credit Units)
BOT 863	Landscape Restoration Ecology	(3 Credit Units)
BOT 854	Environmental Audit and Impact Assessment	(3 Credit Units)

Plant Anatomy

BOT 823	Taxonomic Data Processing and Presentation	(3 Credit Units)
BOT 824	Developmental Plant Anatomy	(3 Credit Units)
BOT 825	Anatomy of Phloem Cells	(3 Credit Units)
BOT 826	Advanced Plant Anatomy	(3 Credit Units)
BOT 827	Secondary Growth in Plants	(3 Credit Units)

Biosystematics/Taxonomy

BOT 823	Taxonomic Data Processing and Presentation	(3 Credit Units)
BOT 828	Advanced Herbarium Studies	(3 Credit Units)

BOT 826	Advanced Plant Anatomy	(3 Credit Units)
BOT 829	Principles and Procedures of Plant Taxonomy	(3 Credit Units)
BOT 830	Advanced Plant Systematics	(3 Credit Units)
BOT 845	Palynology	(3 Credit Units)
BOT 831	Cytogenetics, Evolution and Phylogeny	(3 Credit Units)
BOT 844	Biogeography	(3 Credit Units)
BOT 841	Ecology of Cryptograms and epiphytes	(3 Credit Units)

Mycology/ Plant Pathology

BOT 832	Physiology of Plant Diseases	(3 Credit Units)
BOT 833	Advanced techniques in Biology	(3 Credit Units)
BOT 834	Advanced Phytopathology	(3 Credit Units)
BOT 835	Viral and Mycoplasma Diseases	(3 Credit Units)
BOT 836	Physiology of Parasitism	(3 Credit Units)
BOT 837	Control of Plant Diseases.	(3 Credit Units)
BOT 849	Advanced Mycology	(3 Credit Units)
BOT 853	Mushroom Science	(3 Credit Units)

Aquatic Botany

BOT 813	Bioinformatics	(3 Credit Units)
BOT 850	Limnology	(3 Credit Units)
BOT 851	Advanced Primary Productivity	(3 Credit Units)
BOT 852	Advanced Algology	(3 Credit Units)
BOT 847	Ecology of Aquatic Macrophytes	(3 Credit Units)
BOT 854	Environmental Audit & Impact Assessment	(3 Credit Units)
BOT 818	Ecosystems Pollution Ecology	(3 Credit Units)

Plant Ecophysiology

BOT 814	Plant Growth Regulatory Substances	(3 Credit Units)
BOT 815	Growth and Developmental Physiology in Plants	(3 Credit Units)
BOT 817	Techniques in Plant Ecology	(3 Credit Units)
BOT 818	Ecosystems Pollution Ecology	(3 Credit Units)
BOT 819	Physiological Plant Ecology	(3 Credit Units)
BOT 820	Air Pollution and plant degradation.	(3 Credit Units)
BOT 864	Plant Adaptation and Acclimation Mechanisms	(3 Credit Units)
BOT 854	Environmental Audit and Impact Assessment	(3 Credit Units)

Environmental Botany

BOT 817	Techniques in Plant Ecology	(3 Credit Units)
BOT 818	Ecosystems Pollution Ecology	(3 Credit Units)
BOT 819	Physiological Plant Ecology	(3 Credit Units)
BOT 820	Air Pollution and plant degradation.	(3 Credit Units)
BOT 854	Environmental Audit & Impact Assessment	(3 Credit Units)
BOT 843	Phytoremediation	(3 Credit Units)
BOT 863	Landscape Restoration Ecology	(3 Credit Units)
BOT 865	Forest and Savanna Ecology	(3 Credit Units)

Phytomedicine/ Ethnomedicine

BOT813	Bioinformatics	(3 Credit Units)
BOT 830	Advanced Plant Systematics	(3 Credit Units)
BOT 842	IPR and Patent Law	(3 Credit Units)
BOT 855	Plant Genetic Resources Management & Utilization	(3 Credit Units)
BOT 860	Introductory Pharmacology	(3 Credit Units)

BOT 856	Herbal Materia Medica	(3 Credit Units)
BOT 857	Herbal Medicine: Philosophy, Policy and Ethics	(3 Credit Units)
BOT 858	Herbal Clinical Internship	(4 Credit Units)
BOT 859	Medicinal Mycology	(3 Credit Units)
BOT 861	Ethnobotany, Nutrition and Health	(3 Credit Units)
BOT 804	Advances and Current Techniques in Plant Breeding	(3 Credit Units)

5.1.3 Synopsis of The Core Courses

SCI 802 ICT and Research Methodology (3 Credit Units)
This course should cover essentials of Spreadsheets, Internet technology Statistical Packages, Precision and Accuracy of Estimates, Principles of Scientific Research, Concepts of Hypotheses Formulation and Testing, Organization of Research and Report Writing.

SCI 801 Management and Enterpreneurship (2 Credit Units)
The course will cover business environment, general management, financial management, entrepreneurship development, feasibility studies, marketing and managerial problem solving.

BOT 804 Advances and Current Techniques in Plant Breeding (3 Credit Units)
Goals of plant breeding. Plant introduction and germplasm collections. Centers of genetic diversity and origin of cultivated plants. Genetic basis of selection: pure line theory, quantitative inheritance and heritability. Apomixis, incompatibility and sterility. Haploidy and polyploidy and their significance in plant breeding. Uses of anueploids in plant breeding. Breeding methods for self and cross-fertilized crop species. Backcross breeding, mutation breeding, resistance breeding for diseases, pests and drought. Quality breeding, seed testing and certification. Cell fusion and anther culture in plant breeding. Crop domestication and utilization in medicine.

BOT 805 Field Studies of Nigerian Flora (3 Credit Units)
An intensive field investigation into the taxonomy and ecology of critical groups of vascular and non-vascular plants. Indicator species for major biomes in Nigeria. Threatened and Endangered plant species in Nigeria. Invasive plants; Exotic invasives (Management, law and legislation)

BOT 806 Science, Environment and Innovations (3 Credit Units)
Element of global warming, environmental protection issues, biodiversity, pollution, species at risk, social and ethical implications of science, enterprise and productivity, intellectual property rights, private public partnership and investment will be covered in this course.

BOT 811 Evolution and Diversity of Major Plant Groups (3 Credit Units)
Origin of plants: Green algae – multicellular and mosses as aquatic ancestors. Movement of land: moses and liverworsts. Characteristics of first terrestrial plants. Origin of seeds. Evolution of higher plants and their diversity. Importance of plant diversity. Relationship between families of flowering plants. Diversity and evolution of gymonosperms. Reticulate evolution of higher plants. Evolution of flower. Ecological importance of species diversity.

BOT 807 Advanced Cytogenetics (3 Credit Units)
In depth study of evolution of genophores chronomosome structure and function. Karyotype evolution. Structural changes in chromosomes – duplication and deficiency, inversion etc. The study of lethal system. Polyploidy types, characteristics and evolutionary significance. Induction of autopolyploidy and alloploid current issues in advanced cytogenetics.

BOT 808 Advanced Molecular Genetics (3 Credit Units)
The fine structure of the gene. DNA and the genetic code. Mutation and the code. In-born errors of metabolism. Genetic engineering, Genetic mapping, Genetic regulation of development. Selected papers in biochemical genetics.

BOT 809 Population Genetics (3 Credit Units)
Forces in population dynamics. Estimation of population parameters. Models. Selected papers in population genetics.

BOT 810 Radiation Genetics In Plants (3 Credit Units)
Comparison of spontaneous and induced mutations. Mutation, selection and population fitness. Types of oinizing radiation and their cytogenetic effects. Comparison of radiation and chemical mutagenic effects. Effects of preirradiation and post irradiation. Factors modifying irradiation of successive generations. Spontaneous and induced mutations in vegetatively propagated species. Methods of utilizing induced mutations in crop improvement and propagation.

BOT 812 Evolutionary Mechanisms (3 Credit Units)
The synthetic theory of evolution and its development. The sources of variability. The nature of mutation, its causes and adaptiveness. The organization of genetic variability. The differentiation of population. Reproductive isolation and the origin of species. The role of hybridization and polyploidy in evolution. Major trends of evolution. Current issues in evolution.

BOT 813 Bioinformatics (3 Credit Units)
Sequence retrieval and analysis, bioalgorithms, biological databases and their search, sequence alignment and construction of phylogenetic trees, Gene predictions, RNA and protein structure prediction, Use of bioinformatics tools in biotechnology biopharma.

BOT814 Plant Growth Regulatory Substances (3 Credit Units)
The auxins, chemical nature and roles of auxin translocation. Gilbberellins: chemical nature an roles of Gilbberellins, translocation of Gilbberellins. The cytokinins: roles of the cytokinins, synthesis of cytokinins. Absicic acid: roles of absicic acid. Vitamins. Ethylene: effects of ethylene. Other hormone – like substances in plants. Mechanism of hormone action. Interactions among hormones. Ecological importance of hormonal actions

BOT 815 Growth and Developmental Physiology in Plants (3 Credit Units)
Plant growth: Effects of irradiance, light quality, temperature, duration of light on reproductive growth. Seasonal and geographic aspects of photoperiodism. Long-day, and short-day plants as the basic categories. Photoperiodic induction, mechanism of photoperiodism. Rhythmic behaviour of plant processes. Growth and vernalization and apical dominance Cyclical periodicity abscission and mechanism of abscission. Dynamics of primary vegetative growth. Totipotency. Measures of indices of growth and rates of growth. Alternative ways of plant growth for their products for world market. Hormones in horticulture and agriculture.

BOT 816 Biological Techniques (3 Credit Units)
Phytochemical Methods: Electrophoresis, chromatography, anatomical and histological techniques. To demonstrate chemical processes involved in variety of biologically important processes e.g., photosynthesis, mitrochondrial respiration, nitrogen fixation, and carbon transfer etc.

BOT 817 Techniques in Plant Ecology (3 Credit Units)
Plant sampling techniques in aquatic, forest and savanna ecosystems. Elements of forest mensuration; Data collation, cleaning, coding, information retrieval, significance testing, multiple and partial correlation and regression. Classification, clustering, ordination and principal component analysis. Ecosystem modelling and systems approach to ecological problem.

BOT 818 Ecosystems Pollution Ecology (3 Credit Units)
The study of major pollutants: oil and petrochemical, heavy metals, solid wastes of aerial, terrestrial and aquatic environment and their effects on other components of ecosystems. The study of radiation and plant life. Survey of environmental pollution control and measures.

BOT 819 Physiological Plant Ecology (3 Credit Units)
In-dept consideration of the physiological aspects of plant physical/chemical environmental relationships. Emphasis is placed on field problems relating to productivity limitations and environmental stress. Ecosystem functioning.

BOT 820 Air Pollution and Plant Degradation (3 Credit Units)
Air pollution: Types of pollutants. Tissue degradation. Effects of pollution – impacts of air pollutants on crops, semi – and natural vegetation. Impacts of ozone pollution on vegetation and atmospheric deposition of heavy metals to vegetation. Impact of pollutant mixtures (e.g., ozone and nitrogen). Acid rain. Consequences of air pollution for biodiversity, modifying influence of climate change and impact of air pollutants on vegetation.

BOT 821 Production Ecology (3 Credit Units)
The characteristics of fresh water brackish, marine, wetland and habitats and their effects on ecosystem production processes including ecosystem structure and architecture laws governing energy transformation in nature – Food chains and Food webs etc. Wetland conservation (Government policies governing wetland conservation).

BOT 823 Taxonomic Data Processing and Presentation (3 Credit Units)
Collection of plants; preparation of herbarium specimens; preparation of microscope slides. Geographical and morphological methods in presentation of data, literature mapping, tabulation, symbolic and graphical methods. Identification: keys, comparison with named materials, nomenclature. Use of methods of numerical taxonomy in construction of taxonomic groups. Relevance of taxonomy in plant identification and usage.

BOT 824 Developmental Plant Anatomy (3 Credit Units)
Review of root, stem and leaf initiations in plants. Studies on the epidermal tissue system, their functions and distribution – stomata, cuticle, trichomes, epiblems, piliferous layer. The ground or fundamental tissue systems, their function and distribution – cortex, endodermis, pericycle, pith and pith rays (parenchyma, collenchyma and sclerenchyma). The vascular tissue system: elements of vascular bundles – xylem: protoxylem and metaxylem; phloem – protophloem and metaphloem. Cambium: types of vascular bundles.
A comprehensive knowledge of leaves – leaf epidermis, mesophyll palisade parenchyma, spongy parenchyma and vascular bundles of gymnosperms and angiosperms.

BOT 825 Anatomy of Phloem Cells (3 Credit Units)
Studies on the origin and distribution of phloem should be reviewed. Primary phloem, sieve elements secondary phloem, structure and components of secondary phloem, companion cells, phloem fibres and sieve, parenchyma cells. Periderm – meaning and occurrence. Phellogen and phelloderm, initiation of periderm. Activity of phellogen, distribution of lenticels, ultra structure of plant cell wall, the pit fields chemical aspect of cell wall lignin, cellulose, hemicellulose etc. principal uses of phloem cells.

BOT 826 Advanced Plant Anatomy (3 Credit Units)
The structure of the cell wall. Cambium and its activities. Types, characteristics and structure of wood fibre, wood pulping, Bullressing and its use in the industry.

BOT 827 Secondary Growth in Plants (3 Credit Units)
Origin and distribution of xylem. Components of xylem vessels secondary growth in dicotyledonous plants should be treated. The activities of cambium, origin and activity, cork cambium, secondary cortex should be emphasized in respect of wood formation and annual rings in plants. Emphasis should be laid on the origin of cambium, structure and cell types. Ray initials: size, variation, cell arrangement (stored and non-stored). The uniseriate and multiseriate concepts of cambium structure. Importance of cambium. The dimensions of wood, groups of wood (soft and hard wood). Apotracheal and paratracheal wood nature – Rays in hard and soft woods. General studies on the nature and structure of pits as found in hard and soft woods, fibre and vessels. Significance of pit and pit membranes. Cambia and cambial activity in both angiosperm and gymnosperms. Physiology of cambial activity, metabolism of cambium (enzymes activity, temperature, soil nutrient, light intensity and photoperiodism effect on cambial activity). Uses in wood structure and utilization.

BOT 828 Advanced Herbarium Studies (3 Credit Units)
The herbarium, and economic botany, Conservation and Taxonomy, Types of herbaria, the Herbarium building, purpose of a herbarium and the Herbarium labels, Herbarium materials, Preservation techniques. Introduction to Herbarium techniques and management. Storage methods. Seed banks and their management. Photography in Herbarium practice. Herbarium legislation.

BOT 829 Principles and Procedures of Plant Taxonomy (3 Credit Units)
Historical background: the natural system and the value of character. Phenetric and phylogenetic concept in taxonomy including rules and nomenclature, the categories in taxonomy. Evolution, identification of flowering plants. Recent trends in plant taxonomy.

BOT 830 Advanced Plant Systematics (3 Credit Units)
A survey of floral morphology in relation to classification and evolution, chromosome numbers, polyploidy and their role in taxonomy. Flow cytometry as a taxonomic tool. Chemotaxonomy.

BOT 831 Cytogenetics, Evolution and Phylogeny (3 Credit Units)
Chromosomal organization in relation to gene environment, genetic recombination in population – the use of genetic system in evolution, the origin of species hybridization its origin and its significance polyploidy – occurrence, distribution and its importance.

BOT 832 Physiology of Plant Diseases (3 Credit Units)
Degradation of host plant tissue by pathogens, breakdown of cellulose; unienzyme theory, two enzyme theory and multi-enzyme theory. Pectic substances, mechanisms of wilting – physiological wilting and pathological wilting; production of toxins blocking of vascular elements by substances Tyloses. Production of enzymes by parasites. Production of substances with growth regulating activity. Respiration of diseased plant. Plant vigor and protection.

BOT 833 Advanced Techniques in Biology (3 Credit Units)
Collection methods, temporary preservation of fresh materials. Preparation of herbarium packets and labelling. Permanent preservation of materials using specific mountants. Microlimatology, types of instruments and their uses.

BOT 834 Advanced Phytopathology (3 Credit Units)
Advances in mechanisms of disease development and control. Methods and materials used in plant disease control and the problems involved in their application. Survey of principles of hand and mechanically operated machinery for applying pesticides. Biological control. The physiology and biochemistry of plant parasitic diseases. Pre and post penetration, interactions of the host and pathogen. Assaying of phytotoxins, phytoalexins, cell wall-degrading enzymes and growth substances produced during pathogenesis.

BOT 835 Viral and Mycoplasma Diseases (3 Credit Units)
A review of plant diseases including distinction between bacterial diseases, fungal disease and viral diseases should be highlighted. Transmission of plant viruses: through insects, animals, mechanical transmission, vegetative propagation, seeds, dodder, fungi, etc. Physical and chemical properties of viruses, virus structure and chemistry; diseases – swollen shoot, cassava mosaic, pepper mosaic. Applications in plant breeding.

BOT 836 Physiology of Parasitism (3 Credit Units)
The study of parasitism and pathogenicity. Entry of pathogens into plants and mechanism of attack. Mechanical forces exerted by pathogens of host tissue. The study of chemical weapons of pathogens enzymes, toxins and growth regulating enzymes. Ethylene and its role. Mechanisms of defense. Applications in wood preservation.

BOT 837 Control of Plant Diseases (3 Credit Units)
The chemical structure and mode of action of fungicides. Factors influencing fungicides. The evaluation of fungicides in the laboratory. Methods of application of fungicides. Different treatments of lumber with fungicides. Application of Nematicides. Current trends in the control of plant diseases.

BOT 839 Advanced Physiology and Metabolism (3 Credit Units)
Energy metabolism, election donors and acceptors and their electron potentials. Enzymes, coenzymes and mechanisms of action. Catabolism and anabolism pathways for proteins, lipids and carbohydrates. Nitrogen fixation and its function in plant development. Types and distribution of proteins, lipids and carbohydrates.

BOT 840 Nutrient Metabolism in Plants (3 Credit Units)
Plant, soil and water relationships. Nutrient uptake; Mechanisms and theories of nutrient uptake; Roles of major and minor plant nutrients in plant metabolism. Nutrient interactions and deficiency symptoms. Biofortification and Genetic improvement of plants for enhanced micronutrient content. Analytical techniques in plant nutrition studies Hydroponics. Techniques in radio labelling/ tracer studies.

BOT 841 Ecology of Cryptogams and Epiphytes (3 Credit Units)
Affinities and evolution of higher algae, bryophytes, pteridophytes, A systematic survey of major vascular and non-vascular epiphytes. Ecology of epiphytes. Functions of epiphytes environmental monitoring and ecosystem stabilization.

BOT 842 IPR and Patent Law (3 Credit Units)
Intellectual Property, Patent law fundamentals, International IP treaties relevant to biotechnology, International agreements relevant to biotechnology-associated IP, Drafting Patent Application, Documentation, Patent Search databases, Revocation of Patent, Litigation and Infringement, Licensing and IP Management, Plant Breeders rights, protection of New plant varieties. Traditional knowledge vis-à-vis industry.

BOT 843 Phytoremediation (3 Credit Units)
Overview of Phytoremediation- Metal bioavailablilty and hyperaccumulation, phytoextraction and phytovolatilization. Rhizofiltration, phytodegradation and phytostabilzation. Soil improvement with organic/plant residues. Phytodegradation of oil, herbicides, pesticides and other organic compounds by plants, bacteria and fungi. Genetic improvement of plants for phytoremediation .Techniques (eg EDXRF, TXRF, micro-PIXE, INAA, and AAS) in phytoremediation studies; Phytoremediation System Selection and Design Considerations; Remedial Objectives, Treatability, and Evaluation; Case Studies

BOT 844 Biogeography **(3 Credit Units)**
Importance of biogeography; Distribution of species, genera and families: Endemic species and genera. Pan tropical species and genera. Discontinuous species and genera; Factors of distribution (climatic, edaphic, geographic and dispersal effects). Theory of tolerance. Floristic regions of the world. Vegetation mapping.

BOT 845 Palynology **(3 Credit Units)**
Pollen diagrams and their interpretation. Fossil vegetation maps. Palynology and mineral oil exploitation. Pollen load of the atmosphere. Pollen grains and allergy.

BOT 846 Weed Biology **(3 Credit Units)**
Weeds in relation to man. Origin and life cycles of weeds. Propagation and weed dissemination. Weed growth, development and establishment. Competitive ability of weeds. Weed-crop association in the tropics. Weed control (chemical, biological etc). selectivity of herbicides.

BOT 847 – Ecology of Aquatic Macrophytes **(3 Credit Units)**
Diversity of aquatic habitats and their vegetation; Growth forms and life form classifications; Distribution and growth of aquatic macropgytes; Reproductive strategies of aquatic macrophytes. Structural and dynamic characteristics of aquatic plant communities: Primary production and energetics; Nutrient uptake and release. Problems and control of noxious weeds: conservation of aquatic macrophytes.

BOT 849 Advanced Mycology **(3 Credit Units)**
Evolutionary patterns of fungi and the criteria used in fungal taxonomy. Fungal ecology in relation to both man and plants. Aeromycology with emphasis on spore liberation and dispersal. Fungal differentiation and biotechnology.

BOT 850 Limnology **(3 Credit Units)**
A limnological treatment of tropical freshwater and brackish water bodies including the physiology and growth of algal species. An advanced discussion of selected topics in the ecology, productivity and systematics of freshwater and marine algae, physical and chemical limnology.

BOT 851 Advanced Primary Productivity **(3 Credit Units)**
Concepts and scope of primary productivity. Comparative account of primary productivity in (1) different habitats (fresh water, estuarine and marine); (2) different geographical zones (polar, tropical and temperate waters, etc.); (3) different seasons (dry, wet, summer, winter, autumn and spring). Contributions to primary prductivity and global energy computation. Measurement of primary productivity. Factors affecting primary productivity.

BOT 852 Advanced Algology **(3 Credit Units)**
Place of algae in Plant kingdom. Algae in the phytoplankton Cyanophyceae, Rhodophyceae, Phaeophyceae, Euglenophyceae. Phytoplankton crop. Nature of culture media. The characteristics of algae growth in cultures of limited volume. The growth of algae in continuous and synchronous culture. Single cell culture. Metabolic patterns and growth.

BOT 853 Mushroom Science **(3 Credit Units)**
The history, basic principles and cultural practices of Mushroom production, including a survey of locally occurring edible species. Various methods of growing mushrooms. Factors affecting growth and basidiocarp formation *in vivo* and *in vitro.* Mushroom abnormalities; their pests and control. Mushroom chemistry, including nutritive value, poisons and treatment. Growth habits of selected local species of edible mushrooms.

BOT 854 Environmental Audit and Impact Assessment (3 Credit Units)
Objectives of EIA. Resources required for EIA. Basic principles of EIA. Site selection, environmental screening and preliminary assessment. Scoping of signification issues; Impact identification, prediction, measurement and evaluation. Identification of monitoring and mitigating measures. Documentation of EIA. Environmental impact statement. A selected survey with case studies.

BOT 855 Plant Genetic Resource Management and Utilization (3 Credit Units)
Management of genetic resources data. Indigenous management of plant genetic resources. Plant genetic resources characterization and evaluation. Sampling and conservation strategies. *In situ* and *ex situ* conservation. *In vitro* storage of genetic materials. Reserves, protected areas and botanic gardens. Plant genetic resources in Agriculture and Biotechnology.

BOT 856 Herbal Materia Medica (3 Credit Units)
Remedies grouped according to primary therapeutic action: stimulants, relaxants, astringents, depuratives, demulcent, antiseptics, diuretics, cardiovascular agents, diaphoretics, pulmonary agents, hepatic, cholagogues, gastro- intestinal agents and nervines.

BOT 857 Herbal Medicinal Practice: Philosophy Policy and Ethics (3 Credit Units)
History of Herbal Medicine, the whole person and homeostasis, vitalism, health and disease, essentials of health, rational therapy, herbal approach to treatment, pain and its rational treatment, micro-organisms and disease, the germ theory, poisonous and safe medicines. The Herbal Practitioner and the Law, Supply of Remedies. Code of Ethics and Rules of Practice in relation to biodiversity prospecting and conservation on medicinal plants.

BOT 858 Herbal Clinical Internship (4 Credit Units)
The purpose of the clinical Training is to enable the students to combine and take thorough case histories, follow up consultations, learn examination techniques, formulate and dispense herbal remedies. Eight (8) weeks of clinicals supervised by Clinic Practitioners.

BOT 859 Medicinal Mycology (3 Credit Units)
Basic structure and biology of fungi. Systematic survey of fungi with medicinal properties. Fungi as sources of antibiotics. Medicinal and food value of mushrooms. Historical, folklore of fungi. Hallucinogen mushroom in primitive culture. Ergots of rye and ergotism in humans and animals. Biopharmaceutins of fungal origin. Industrial uses of fungi.

BOT 860 Introductory Pharmacology (3 Credit Units)
Pharmacokinetics: absorption, distribution, metabolism and excretion of remedies, Basic components: acids, alcohols, carbohydrates, gums and mucilages, phenols, tannins, coumarins, anthraquinones, flavones an derivative, volatile oils, saponins, cardioactive and cyanogenic glycosides and alkaloids. Remedies and their pharmacology for the urinary system, cardiovascular system, digestive system, respiratory system, nervous system, endocrine system, reproductive system, the skin, infectious conditions and tumours. Allopathic remedies.

BOT 861 Ethnobotany, Nutrition and Health (3 Credit Units)
he nature and ecological significance of food and medicinal plant biodiversity in traditional subsistence systems; scientific, institutional and ethical issues in ethnobotany; evaluation, application and management of plants and Indigenous Knowledge of plants to address contemporary health and nutrition problems.

BOT 863 Landscape Restoration Ecology (3 Credit Units)
Causes and effects of land degradation; deforestation, overgrazing, over cultivation, fire/bush burning, soil erosion, contamination by oil, pesticides and other polyaromatic hydrocarbons (PAHs). Forest decline and soil acidification. Land restoration and reclamation. Plant species selection and planting materials. Nursery and field practices for reforestation/re-vegetation. Watershed

management. Ecological succession. Energy and nutrient dynamics of climax communities. Landscape horticulture.

BOT 864 Plant Adaptation and Acclimation Mechanisms (3 Credit Units)
Phenotypic plasticity and acclimation mechanisms. Physiological responses to drought, heat, salinity and acidity. Heat shock proteins (HSPs). Secondary metabolites and plant defense responses to abiotic stress, herbivory and pathogens. Plant hormonal response mechanisms. Free radicals in plant stress phenomena. Anti-oxidants in plant stress responses. Metal tolerance, accumulation and the phytochelatin response.

BOT 865 Forest and Savanna Ecology (3 Credit Units)
Community structure of tropical rainforests and Savanna ecosystems. Natural and man-made forests. Habitat characteristics and Biodiversity. Global warming. Roles of forest in carbon sequestration and modification of microclimate. Ecological factors that affect the productivity of forests and savanna ecosystems. Nutrient cycling and ecosystem dynamics. Deforestation and forest regrowth. Land use practices and Nigerian vegetation profile. Fire as a management tool in forests. Savanna forest fires. Timber and non timber forest products (NTFPs). Forestry administration and management programmes in Nigeria. Community forests. Forestry policies and legislation. Forest conservation and the Nigerian protected area system.

BOT 800 Seminar (2 Credit Units)
A candidate for the M.Sc. degree will be required to present a seminar on a topic selected from within the study area before the Departmental Postgraduate Committee. The performance of a candidate shall be evaluated for the award of marks by a panel selected by the Departmental Postgraduate Committee.
Apart from the oral presentation, the seminar shall be typewritten, soft-bound and submitted to earn credit.

BOT 899 Project Work (6 Credit Units)
A candidate for the M.Sc. degree shall undertake an independent research in the particular field of specialization under the guidance of a supervisor appointed by the Department Postgraduate committee and approved by the Postgraduate School and the University Senate. A report on the research project shall be submitted to the Department. The candidate shall be examined orally by a panel of external and internal examiners.

6 BREWING SCIENCE

6.1 Postgraduate Diploma Programme

Requirements for Graduation:

Courses	**Credit Units**
Core Courses	15
Electives	9
Research Project	4
Total	28

Core Courses		**Credit Units**
BST 701	Raw Materials in Brewing	3
BST 702	Brewhouse Technology	3
BST 703	Brewing Fermentation	3
BST 704	Beer Treatment and Packaging Technology	3
BST 705	Seminar	3
	Total	15

Electives		
BST 706	Brewing Process Engineering	3
BST 707	Brewing Microbiology	3
BST 708	Technology of Alcoholic and Non Alcoholic Beverages Production	3
BST 709	Food Standards and Quality Control	3
BST 710	Food Analysis and Instrumentation I	3
BST 711	Research Methodology and Statistics	3
BST 712	Research Project	4

6.2 Masters In Brewing Science

Requirements for Graduation:

Courses	**Credit Units**
Core/General Courses	18
Electives	6
Disertation/Thesis	6
Total	**30**

General Course			
SCI	801	Management and Entrepreneurship	2
SCI	802	ICT and Research Methodology	2

Core Course			
BST	813	Malting and Brewhouse Theory	3
BST	814	Yeast Technology and Brewing Fermentation	3
BST	815	Brewing Process Plant Design	2
BST	816	Starch Technology and Syrup Production	3
BST	817	Seminar	3
	Total		14

Electives			
BST	818	Advanced Food Microbiology	2
BST	819	Advanced Food Chemistry	2

BST	820	Engineering Properties of Foods	2
BST	821	Food Analysis and Instrumentations 11	2
BST	822	Food Biotechnology	3
BST	823	Food and Bio-processing Systems	3
		Total	**14**
BST	824	Dissertation/Thesis	6

6.3 Doctor of Philosophy (Ph.D.) Programme In Brewing Science

Requirements for Graduation			
Core Courses/Seminar			12
Thesis			12
	Total		**24**
	Core Courses		
BST	925	Recent Advances in Brewing Science	3
BST	926	Advanced Food Fermentation	3
BST	927	Microbial Genomics	3
BST	928	Seminar	3
		Total	**12**
BST	929	Thesis	12

6.4 Synopsis of Courses

BST 701 Raw Materials in Brewing (3 Credit Units)
Cereal grains, malt, hops (physiology, biochemistry and processing); water (sources, purification, treatment); adjuncts (types and production)

BST 702 Brewhouse Technology (3 Credit Units)
Milling, mashing, wort production (equipment processes and treatment); mashing systems, wort filtration and separation; wort boiling and hopping; wort cooling; high gravity brewing.

BST 703 Brewing Fermentation (3 Credit Units)
History of brewing fermentations; brewing yeast (structure, physiology, characteristics); biochemistry of fermentation, brewery fermentation rooms and vessels; control and regulation of fermentation; problem fermentations; secondary fermentation; conditioning and maturation.

BST 704 Beer Treatment and Packaging (3 Credit Units)
Beer stabilization methods. Clarification and filtration techniques. Exclusion of air. Chilling and carbonating. Container filling and sealing equipment and their operating principles Pasteurization and other methods of beer stabilization. Physical and chemical properties of beer. Beer sensory evaluation. Maintenance of equipment and corrective measures for variance in packaged product quality.

BST 706 Brewing Process Engineering (3 Credit Units)
Fundamentals of mass and energy balance. Fluids. Mass, energy and momentum relationship for fluids in pipes and channel. Flow measurement. Valves, Pumps and pumping of fluids. Solid-liquid separation. Filtration, sedimentation. Mixers and mixing of liquids. Principles of heat transfer. Heat transfer equipment and heat transfer area. Steam generation and usage. Steam tables and their uses. Mollier chart and how they are used. Drying, Humidification, Principles of refrigeration, types and characteristics of refrigerants, compressors, evaporators and their characteristics: Material handling and size reduction. Materials of construction. Accoustics, Electricity. Instrumentation and Process Control.

BST 707 Brewing Microbiology (3 Credit Units)
Micro-organism involved in brewing (yeasts and moulds, bacteria) detection and enumeration, fermentation by micro-organisms; beer spoilage micro-organisms; microbial quality control methods and standards.

BST 708 Technology of Alcoholic and Non-Alcoholic Beverages production (3 Credit Units)
History, Raw materials, Fermentation, Distillation, Maturation and aging, Blending and colouring, Organoleptically important components of Whisky, Rum, Gin, and Vodka, Wine, Cider and Perry and other drinks.

BST 709 Food Standards and Quality Control (3 Credit Units)
The importance of food standards and legislation. Food and drug laws. Codex Alimentarius. Food standards and legislation in Nigeria. Food quality, quality control, quality assurance and cost, principles of quality control, sensory evaluations, microbiological, chemical quality control, statistical quality control. Use of control charts for the food industry.

BST 710 Food Analysis and Instrumentation I (3 Credit Units)
Analysis of lipids, proteins, carbohydrates, toxicants, minerals, vitamins and food additives. The principle and application of gas liquid chromatography, high performance liquid chromatography (including gel permeation and ion exchange chromatography), electrophoresis, polarimetry, spectrophotometry (visible, ultraviolet, infrared) and fluorimetry in food analysis.

BST 711 Research Methodology and Statistics (3 Credit Units)
Definition of Research. Research types, Historical, Case studies, Surveys, Descriptive, Cross sectional, Experimental. Major steps in research: Selection of problem, Literature review, Design, Data collection, analysis and interpretation, Conclusions. The scientific method: features, Experiments: Sampling etc, planning, analysis and design of experiments. Use of controls, randomization, paired subjects, cross-over, factorial designs, reduction of experimental error, degrees of freedom. Format of report writing Bibliography. Definition and formats.

General Courses

SCI 801 Management and Entrepreneurship (2 Credit Units)
The course will cover business environment, general management, financial management, entrepreneurship development, feasibility studies, marketing and managerial problem solving.

SCI 802 ICT and Research methodology (2 Credit Units)
This course should cover essentials of Spreadsheets, Internet technology Statistical packages, Precision and Accuracy of Estimates, Principles of Scientific Research, Concepts of Hypotheses Formulation and Testing, Organization of Research and Report Writing.

BST 813 Malting and Brewhouse Theory (3 Credit Units)
Cleaning and storage of cereal grains. Outline of malting, Barley and sorghum grains-their anatomy and physiology. Steep liquor and steeping schedules. Malt modification enzymes, Layout of brewhouse equipment and silo operation. Milling; objectives and types. Mashing: objectives, biochemistry, mashing systems, equipment. Wort Boiling and hopping. Wort cooling, High gravity brewing. Brewing calculations.

BST 814 Yeast Technology and Brewing Formation (3 Credit Units)
Brewing yeast structure. Yeast cell wall in relation to flocculence, fining and head retention. Yeast propagation and purification. Improvement of brewing strains by hybridization, rare mating, cytoduction, killer yeasts, mutation etc. Large scale manufacture of yeasts for commercial purposes. Yeast products and their uses. Biochemistry of fermentation: changes from wort to beer. Batch and

continuous culture Main fermentation rooms and vessels. Control and regulation of fermentation. Secondary fermentation.

BST 815 Brewing Process Plant Design (2 Credit Units)
Plant lay-out in the brewing industry. Economics of process design and optimization techniques Optimum design of brewing process plants and distilleries.

BST 816 Starch Technology and Syrup Production (3 Credit Units)
Sources of starch. Chemical composition and structure. Physico-chemical modification and degradation of starch. Enzymic degradation o starch. Fermentation products from starch from starch. The technology of corn wet milling. Other products that can potentially be prepared from starch e.g. glucose syrups and flakes, fuels, alcohols, organic acids, penicillins, enzymes, amino acids and microbial polysaccharides.

BST 818 Advanced Food Microbiology (2 Credit Units)
The microflora of foods. Beneficial and harmful food microorganism. Food as a substrate for microbial propagation. Relationship of microorganisms to food spoilage including biochemical breakdown of nutrients. Food poisoning; type of microorganisms, toxin produced and mode of poisoning.

BST 819 Advanced Food Chemistry (3 Credit Units)
Non-starch polysaccharides. Natural processes involved in synthesis and degradation of foods. Photosynthesis, respiration, maturation, senescence. Chemical changes that occur in foods during and after processing. Food pigments and other colourants. Food flavor compounds. Effects of maturation and processing on pigments and flavor compounds.

BST 820 Engineering Properties of Foods (2 Credit Units)
Detailed study of engineering properties of foods (liquid, semi-solid and solid) and their effects on formulation, processing, preservation and quality appearance of finished products. Effect of particle size on texture foods.

BST 821 Food Analysis and Instrumentation II (2 Credit Units)
Principles and practice of food analysis, sample preparation. Chromatography including high performance liquid chromatography, spectrophotometry, flame photometry etc. Electrophoresis, isoelectric focusing, viscometry, membrane filtration. Determination of food contamination and indicators of food spoilage. Modern techniques in food analysis.

BST 822 Food Biotechnology (3 Credit Units)
Application of biotechnology in the food industry. Traditional fermentation including optimization and expansion. Detoxification. Processing aids. Biotechnology in new product development and food ingredients. International and unintentional application in food processing. Quality improvements of food products.

Fermented foods of tropical and temperate countries. Oriental fermented foods. Production of vitamins, amino acids, polysaccharides, polyhydroxy alcohols by fermentation. Microbial enrichment of fermented foods – single cell proteins, emphasis to be placed on fundamental chemical reactions involved and conditions affecting fermentative efficiency.

BST 823 Food and Bioprocessing Systems (3 Credit Units)
Heat processors – pasteurizers, irradiators, microwaves and ohmic heaters. Dehydration and concentrating processors, dryers (air and vacuum), Evaporators open kettles, flash, thin film, vacuum and freezed-dry evaporators, ultrafiltration and reverse osmosis processes Fermenters:- for microbial biomass and biogass, microbial metabolites and microbial enzymes and microbially transformed compounds (eg beer, wine and vinegar). Batch and continuous processes – merits and

demerits. In all systems emphasis will be placed on design of equipment and the chemical effects on foods.

BST 925 Recent Advances in Brewing Science (3 Credit Units)
Indepth review and analysis of recently published advances in brewing science and technology. Results of reviews to be written as term papers and presented in course seminars.

BST 926 Advanced Food Fermentations (3 Credit Units)
Microorganisms involved in fermentation. Nature and types of substrates for fermentation. Culture improvement for industrial purposes. Design and types of fermenters. Batch and continuous fermentation. Product recovery and purification. Enzyme and whole cell immobilization processes. Single cell protein products, Industrial applications.

BST 927 Micobial Genomics (3 Credit Units)
Introduction mapping of prokaryotic genomes eg. E coli, gene libraries, sequencing; experimental techniques; hybridization tests. Yeast(*S.Cerevisiae*) genome. Pattern of gene expression – SAGE DNA chip technology, etc. Functional genomics – computer analysis, experimental analysis; Proteomics.

7 CHEMISTRY

7.1 Master's Degree in Chemistry

Area of Specialization in Chemistry

a. Industrial Chemistry
b. Inorganic/Co-ordination Chemistry
c. Physical/Theoretical and Computational Chemistry
d. Organic/Natural Products Chemistry
e. Environmental Chemistry
f. Analytical Chemistry

Postgraduate students at the Master's degree level are expected to earn a minimum of 30 credit units comprising of 12 credit units of the core chemistry courses, 12 credit unit of Electives and 6 credit units of project.

7.1.1 MSc Industrial Chemistry

	Courses	Status
1.	Heterogeneous and Homogeneous catalysis	C
2.	Separation Methods of Analysis	C
3.	Advanced Applied spectroscopy	C
4.	Recent Advances in Coordination Chemistry	C
5.	Food and Drug Analysis	E
6.	Water Analysis	E
7.	Analysis of Miscellaneous Materials	E
8.	Oil refining	E
9.	Special Topics in Physical Chemistry	E
10.	Advanced Natural Products Chemistry	E
11.	Research Project	

Course Description

Homogeneous and Heterogeneous catalysis
General principles of heterogeneous catalysis, Activity patterns, Efficiency of catalysts, Effects of temperature, Rates and kinetic models of catalytic reactions, Pulse microreactors, catalytic hydrogenation, olefin oxidation, carbonylation, oligomerisation and dimerisation, General methods of catalyst manufacture and quality evaluation, Trends in heterogeneous catalysis in the 21st century and beyond

Oil refining
Crude oils, distillation processes, catalytic reforming and isomerisation, hydrocracking and treatment processes, catalytic cracking, desulphurisatioon, Alkylation reactions, Product quality and motor gasoline refinery schemes, kinetics of polymerization systems, polymer processing.

Separation Methods of Analysis:
Solvent extraction, Thin Layer chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Paper chromatography, Gas chromatography.

Food and Drug Analysis:
Food composition. Methods of analysis of food for proximate composition, vitamins, mineral additives, Food contaminants. Food quality control. Analysis of major groups of commonly encountered Drugs. Foods and Drugs Regulatory Control.

Water Analysis:
Water quality parameters for various (Industrial, Agricultural and Domestic) uses. Methods of analysis of water for various quality parameters. Analysis for trace organics. Water pollution control and treatment.

Analysis of Miscellaneous Materials:
Analysis of air, soils, minerals, rocks, and other miscellaneous materials.

Recent Advances in Inorganic/organometallic chemistry
Synthetic pathways, Bonding structural stereo-chemical aspects, complex structures and site preference for regular symmetry, Electronic states, spectra, magneto-chemistry, organometallic chemistry

Special topics in Physical chemistry

Advanced Natural Product chemistry
Selected topics in Natural products biosynthesis. Chemistry of heterocycles, insect chemistry Alkaloids, terpenes, flavonoids, and steroid chemistry. Marine natural products, Glycocides biosynthesis.

Advanced Applied Spectroscopy:
Basic instrumentation and techniques, Applications of UV, IR, NMR and MS in chemical analysis and structural elucidation. High resolution NMR and ^{13}C-NMR and other nuclei, shift reagents, All ion structure and fragmentation, Field desorption, Fast atomic bombardment, Recent applications of linked scan Mass spectrometer

Project:

7.1.2 MSc Inorganic Chemistry

Courses	**Status**
Separation Methods of Analysis	C
Recent Advances in Coordination Chemistry	C
Advanced Applied spectroscopy	C
Heterogeneous and Homogeneous catalysis	C
Molecular Polyhedral	E
Special topics in Inorganic chemistry	E
Special Topics in Physical Chemistry	E
Advanced Natural Products Chemistry	E
Research Project	

Course Description

Homogeneous and Heterogeneous catalysis
General principles of heterogeneous catalysis, Activity patterns, Efficiency of catalysts, Effects of temperature, Rates and kinetic models of catalytic reactions, Pulse microreactors, catalytic hydrogenation, olefin oxidation, carbonylation, oligomerisation and dimerisation, General methods of catalyst manufacture and quality evaluation, Trends in heterogeneous catalysis in the 21st century and beyond

Separation Methods of Analysis:
Solvent extraction, Thin Layer chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Paper chromatography, Gas chromatography.

Recent Advances in Inorganic/organometallic chemistry
Synthetic pathways, Bonding structural stereo-chemical aspects, complex structures and site preference for regular symmetry, Electronic states, spectra, magneto-chemistry, organometallic chemistry

Molecular Polyhedral
Electron deficient compounds-Borohydrides, Synthesis and reactivity, structure and bonding, Carborates and metalloborates, Transition metal clusters synthesis, reactivity and bonding, Metal clusters, homogeneous and heterogeneous catalysis in industrial processes.

Special Topics in Inorganic Chemistry

Special Topics in Physical Chemistry

Advanced Natural Product chemistry
Selected topics in Natural products biosynthesis. Chemistry of heterocycles, insect chemistry Alkaloids, terpenes, flavonoids, and steroid chemistry. Marine natural products, Glycocides biosynthesis

Advanced Applied Spectroscopy:
Basic instrumentation and techniques, Applications of UV, IR, NMR and MS in chemical analysis and structural elucidation. High resolution NMR and 13C-NMR and other nuclei, shift reagents, All ion structure and fragmentation, Field desorption, Fast atomic bombardment, Recent applications of linked scan Mass spectrometer

Project:

7.1.3 MSc Physical Chemistry

Courses	**Status**
Separation Methods of Analysis	C
Biophysical chemistry	C
Special Topics in Physical Chemistry	C
Advanced Applied spectroscopy	C
Structure and Functions of Biological Macromolecules	E
Heterogeneous and Homogeneous catalysis	E
Recent Advances in Coordination Chemistry	E
Advanced Natural Products Chemistry	E
Research Project	

Course Description

Separation Methods of Analysis:
Solvent extraction, Thin Layer chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Paper chromatography, Gas chromatography.

Recent Advances in Inorganic/organometallic chemistry
Synthetic pathways, Bonding structural stereo-chemical aspects, complex structures and site preference for regular symmetry, Electronic states, spectra, magneto-chemistry, organometallic chemistry

Homogeneous and Heterogeneous catalysis
General principles of heterogeneous catalysis, Activity patterns, Efficiency of catalysts, Effects of temperature, Rates and kinetic models of catalytic reactions, Pulse microreactors, catalytic hydrogenation, olefin oxidation, carbonylation, oligomerisation and dimerisation, General methods of catalyst manufacture and quality evaluation, Trends in heterogeneous catalysis in the 21st century and beyond

Biophysical Chemistry
Physical chemistry of biological macromolecules in solution, Commercial use of amino acids, properties of macromolecules through their molecular weight determination, modern methods for the purification of macromolecules, ligand-ligand studies on protein: multiple equilibria, identical and independent sites and conformational transition, production of enzymes, recombinant protein of high value, DNA replication and recombination, Gene mutation, DNA repair and transposable elements

Structure and Function of Biological Macromolecules
The nature, method of analysis and functional aspects of primary, secondary and quaternary structures of proteins (with specific reference to hemoglobin and myglobin), Enzymes and their functions, The Michaelis-Menten model, the Monod-Wyman-Changeaux model: Allostene enzymes. General binding isotherms: the Adair equation, bases, nucleosides and nucleotides, covalent structure of DNA, The Watson-Crick DNA double helix, sequencing and code.

Special Topics inPhysical Chemistry

Advanced Natural Product chemistry
Selected topics in Natural products biosynthesis. Chemistry of heterocycles, insect chemistry Alkaloids, terpenes, flavonoids, and steroid chemistry. Marine natural products, Glycocides biosynthesis

Advanced Applied Spectroscopy:
Basic instrumentation and techniques, Applications of UV, IR, NMR and MS in chemical analysis and structural elucidation. High resolution NMR and 13C-NMR and other nuclei, shift reagents, All ion structure and fragmentation, Field desorption, Fast atomic bombardment, Recent applications of linked scan Mass spectrometer

Project:

7.1.4 MSc Organic Chemistry

Courses

Separation Methods of Analysis	C
Advanced Natural Products Chemistry	C
Petroleum Geochemistry	C
Application of Geochemical Techniques in Petroleum Exploration and Exploitation	C
Advanced Applied spectroscopy	C
Photochemistry	E
Synthetic methods on Organic chemistry	E
Heterogeneous and Homogeneous catalysis	E
Recent Advances in Coordination Chemistry	E
Special Topics in Physical Chemistry	E
Experimental techniques in Organic chemistry	E
Research Project	

Course Description

Phytochemistry
Phytochemistry of carbonyl compounds, aromatic compounds, olefins, acetylenes and related compounds, photooxidation and reduction, photo elimination, eneone, cycloaddition, and rearrangements, photoreactions, photolysis of heteronitrogen compounds, photocyclisation

Homogeneous and Heterogeneous catalysis
General principles of heterogeneous catalysis, Activity patterns, Efficiency of catalysts, Effects of temperature, Rates and kinetic models of catalytic reactions, Pulse microreactors, catalytic hydrogenation, olefin oxidation, carbonylation, oligomerisation and dimerisation, General methods of catalyst manufacture and quality evaluation, Trends in heterogeneous catalysis in the 21st century and beyond

Separation Methods of Analysis:
Solvent extraction, Thin Layer chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Paper chromatography, Gas chromatography.

Petroleum Geochemistry
Nature and origin of petroleum, Production, accumulation and preservation of organic matter. Petroleum generation, migration and accumulation. Alteration of petroleum, isolation and identification of biomarkers. Isotope geochemistry.

Application of Geochemical techniques in petroleum exploration and exploitation
Petroleum source rock evaluation. Geochemical correlations(oil/oil and oil/source rock). Integration of geochemical, geological and engineering data in solving production problems and reservoir management.

Recent Advances in Inorganic/organometallic chemistry
Synthetic pathways, Bonding structural stereo-chemical aspects, complex structures and site preference for regular symmetry, Electronic states, spectra, magneto-chemistry, organometallic chemistry

Special topics in Physical chemistry

Advanced Natural Product chemistry
Selected topics in Natural products biosynthesis. Chemistry of heterocycles, insect chemistry Alkaloids, terpenes, flavonoids, and steroid chemistry. Marine natural products, Glycocides biosynthesis

Advanced Applied Spectroscopy:
Basic instrumentation and techniques, Applications of UV, IR, NMR and MS in chemical analysis and structural elucidation. High resolution NMR and 13C-NMR and other nuclei, shift reagents, All ion structure and fragmentation, Field desorption, Fast atomic bombardment, Recent applications of linked scan Mass spectrometer

Project:

7.1.5 MSc Environmental Chemistry & Pollution Control

Courses	Status
Hazardous Waste Chemistry and Management	C
Environmental Assessment Techniques	C
Chemical Environmental Pollution Studies	C
Environmental Analysis	C
Practicals / Field Work	C
Classical Methods of Analysis	E
Applied Spectroscopy	E
Water Analysis	E
Analysis of Miscellaneous Materials	E
General Concepts in Environmental Chemistry	E
National and Global Chemical Environmental Issues	E
Seminars/Case Studies In Environmental Chemistry and Pollution Control	
Research Methodology: Analytical	
Data Management & Quality Assurance	E
Separation Methods of Analysis	E
Quantitative Spectroscopic Methods	E
Research Project	

Course Description

General Concepts in Environmental Chemistry
Basic Concepts: Environment, Ecosystem, Pollution, Pollutants Surveillance, Monitoring, Guidelines, Standards, Regulations, Compliance. Transformation of environmental media by anthropogenic activities resulting in priority national and global environmental issues. Institutional and regulatory framework for pollution control, Polluter pays principle, Precautionary Principle, Life Cycle Analysis.

Hazardous Waste Chemistry and Management
Types and classification of hazardous substances and wastes. Environmental chemical processes. Chemistry of inorganic and organic hazardous wastes. Collection, storage, transportation, treatment and disposal methods/technologies of hazardous wastes. Environmental effects of hazardous wastes disposal. Hazardous wastes control. Waste prevention including waste minimization, treatment and disposal. Waste Recycle/Recovery/Reuse and Cleaner Production Technology.

Environmental Assessment Techniques
Principles of environmental assessment including Environmental Impact Assessment (EIA) and Environmental Auditing. Environmental baseline studies. Environmental modelling, GIS methods. Types of environmental impact. Impact identification, prediction, evaluation and mitigation. Environmental monitoring, environmental management plan. Environmental policy and regulations on environmental assessment. Risk assessment.

Chemical Environmental Pollution Studies
Principles of chemical pollution of environmental media (air, soil and water) and associated resources. Water/waste water chemistry, soil chemistry and fate of pollutants, air pollution chemistry, fate, effects and monitoring. Environmental toxicology. Chemistry of persistent toxic substances including Persistent Organic Pollutants (POPs). Environmental Indicators of chemical pollution and marker compounds. Remediation of contaminated environment.

National and Global Chemical Environmental Issues
Climate change and Global warming, Ozone layer depletion, trans-boundary movement of toxic wastes, biological diversity, oil and gas pollution, control of international trade in toxic chemicals / substances, chemical pollution in Nigeria. Strategic Approach to the International Management of Chemicals.

Environmental Analysis
Introduction, principles and applications. Environmental sampling methodology, Sample preservation, processing, etc. Analytical techniques for environmental analysis. Criteria for selection of methods. Analysis of air, water, sediment, fish, clinical samples for inorganic and organic chemical pollutants. Data management and presentation.
Seminars/Case Studies in Environmental Chemistry and Pollution Control:
Literature/field search and presentations on topical and special local, national and global environmental issues.

Practical / Field Work
Laboratory and field work on chemical pollutant characterisation and analysis in various environmental media. Laboratory and field treatment and decontamination of polluted sites, etc.

Research Project:

Research Methodology: Analytical Data Management & Quality Assurance:
Research methodology. Quality assurance and control in laboratory analysis. Analytical data management. Elements of chemometrics including modelling.

Classical Methods of Analysis:
Reaction chemistry of selected elements. Aqueous and non-aqueous acid-base titrimetry, redox titrimetry, complexometric titrations, precipitation titrations. Gravimetry: - types, process, PFHS and contamination. Seminars on applications of classical techniques.

Separation Methods of Analysis:
Solvent extraction, Thin layer chromatography, Ion-exchange chromatography, Ion chromatography, Molecular exclusion chromatography, Paper chromatography, Gas chromatography. High performance liquid chromatography. Super critical fluid chromatography .

Quantitative Spectroscopic Methods:
Atomic absorption spectroscopy (flame and non-flame). Atomic emission spectroscopy (flame and plasma techniques). Emission spectrography. Flame molecular emission (MECA) technique, UV-Visible absorption spectrophotometry, Turbidimetry, Nephelometry, Fluorimetry.

Applied Spectroscopy:
Basic instrumentation and techniques, Applications of UV, IR, NMR and MS in chemical analysis and structural elucidation.

Water Analysis:
Water quality parameters for various (Industrial, Agricultural and Domestic) uses. Methods of analysis of water and wastewater for various quality parameters. Water pollution control and treatment technologies.

Analysis of Miscellaneous Materials:
Analysis of air, soils, minerals, rocks, and other miscellaneous materials.

7.1.6 MSc Analytical Chemistry

Courses

Classical Methods of Analysis	C
Separation Methods of Analysis	C
Analytical Chemistry Practicals	C
Quantitative Spectroscopic Methods of Analysis	C
Environmental Assessment Techniques	E
Chemical Environmental Pollution Studies	E
National and Global Chemical Environmental Issues	E
Research Methodology: Analytical Data Management & Quality Assurance	E
Miscellaneous Advanced Techniques	E
Electroanalytical methods	E
Food and Drug Analysis	E
Water Analysis	E
Analysis of Miscellaneous Materials	E
Applied spectroscopy	E
Research Project	

Course Description

Research Methodology: Analytical Data Management & Quality Assurance:
Research design methods. Quality assurance and control in laboratory analysis. Analytical data management. Elements of chemometrics including modelling.

Classical Methods of Analysis:
Reaction chemistry of selected elements. Aqueous and non-aqueous acid-base titrimetry, redox titrimetry, complexometric titrations, precipitation titrations. Gravimetry: - types, process, PFHS and contamination. Seminars on applications of classical techniques.

Separation Methods of Analysis:
Solvent extraction, Thin layer chroma-tography, Ion-exchange chromatography, Ion chromatography, Molecular exclusion chromatography, Paper chromatography, Gas chromatography. High performance liquid chromatography. Super critical fluid chromatography.

Analytical Chemistry Practicals:
Quantitative Spectroscopic Methods: Atomic absorption spectroscopy (flame and non-flame). Atomic emission spectroscopy (flame, arc/spark and plasma techniques). Emission spectrography. Flame molecular emission (MECA) technique, UV-Visible absorption spectropho-tometry, Turbidimetry, Nephelometry, Fluorimetry.

Miscellaneous Advanced Techniques in Analytical Chemistry:
X-ray methods, Neutron activation and other Radiochemical techniques, Enzymatic and Kinetic methods, Thermal methods of analysis, Automated and Process analyzers.

Electroanalytical Methods:
Potentiometry, Voltammetry, Coulometry Electrogravimetry, Conductometry. Chronopotentiometry.

Food and Drug Analysis:
Food composition. Methods of analysis of food for proximate composition, vitamins, minerals, additives, Food contaminants. Pestiside residues in foods. Food quality control. Analysis of major groups of commonly encountered Drugs. Foods and Drugs Regulatory Control.

Water Analysis:
Water quality parameters for various (Industrial, Agricultural and Domestic) uses. Methods of analysis of water and wastewater for various quality parameters. Analysis for trace organics. Water pollution control and treatment.

Analysis of Miscellaneous Materials:
Analysis of air, soils, minerals, rocks, and other miscellaneous materials.

Applied Spectroscopy:
Basic instrumentation and techniques, Applications of UV, IR, NMR and MS in chemical analysis and structural elucidation.

Project:

Environmental Assessment Techniques:
Introduction and Principles of Environmental Assessment including Environmental Impact Assessment (EIA) and Environmental Auditing. Environmental baseline studies Environmental modeling, GIS methods. Types of Environmental Impact Identification, Prediction, Evaluation, Impact mitigation, Environmental Monitoring. Environmental policy and regulations on Environmental Assessment. Risk Assessment.

Chemical Environmental Pollution Studies:
Introduction and principles of chemical pollution of environmental media (air, soil and water) and associated resources. Water/waste water chemistry, soil chemistry and fate of pollutants, air pollution chemistry, fate, effects and monitoring. Environmental toxicology. Chemistry of Persistent Toxic substances including Persistent organic Pollutants (POPS). Environmental Indicators of chemical pollution and marker compounds. Remediation of contaminated environment.

National and Global Chemical Environmental Issues:
Climate change and Global warming, Ozone layer depletion, trans-boundary movement of toxic wastes, biological diversity, oil and gas pollution, control of international trade in toxic chemicals / substances, chemical pollution in Nigeria.

8 COMPUTER SCIENCE

8.1 Master's Degree in Computer Science

Core Courses for MSc in Computer Science

Generic Core Courses

SCI 801 Management and Entrepreneurship	(2 Credit Units)
SCI 802 ICT and Research Methodology	(2 Credit Units)

Programme Core Courses

CSC 800 Research Project/Dissertation	(6 Credit Units)
CSC 801 Operating Systems	(3 Credit Units)
CSC 803 Advanced Computer Algorithms	(3 Credit Units)
CSC 804 Software Engineering	(3 Credit Units)
CSC 805 Computer Communications and Networks	(3 Credit Units)
CSC 808 Advanced Computer Architecture	(3 Credit Units)
CSC 824: Programming Languages	(3 Credit Units)
CSC 828 Seminar	(2 Credit Units)

Elective Courses

CSC 802: Theory of Computation	(3 Credit Units)
CSC 806 Object Oriented Programming	(3 Credit Units)
CSC 807: Advanced Computer Graphics	(3 Credit Units)
CSC 808: Computer Architecture	(3 Credit Units)
CSC 809: Database Systems	(3 Credit Units)
CSC 810: Artificial Intelligence	(3 Credit Units)
CSC 811: Expert Systems	(3 Credit Units)
CSC 812: Operations Research	(3 Credit Units)
CSC 813: Compiler Design and Construction	(3 Credit Units)
CSC 814: Advanced Topics in Computer Science	(3 Credit Units)
CSC 815: Internet Technology	(3 Credit Units)
CSC 816: Human Computer Interaction	(3 Credit Units)
CSC 817: Digital Signal Processing	(3 Credit Units)
CSC 818: Introduction to Quantum Computation	(3 Credit Units)
CSC 819: Mobile and Adaptive Systems	(3 Credit Units)
CSC 820: Electronic Commerce Technologies	(3 Credit Units)
CSC 821: Bioinformatics	(3 Credit Units)
CSC 822: Designing Complex Software Systems	(3 Credit Units)
CSC 823: Computer Organization	(3 Credit Units)
CSC 825: Digital Picture Processing	(3Credit Units)
CSC 826: Artificial Intelligence	(3 Credit Units)
CSC 827: Advanced Computer Vision	(3 Credit Units)

CSC 801: Operating Systems (3 Credit Units)

Structural design aspects of an operating system: process model, inter-process communication,. synchronization mechanisms, resource management, and scheduling. Protection issues. Implementation issues of modern operating systems. Distributed operating systems. Deadlock detection, recovery, and avoidance. Case studies. Project(s).

CSC 802: Theory of Computation (3 Credit Units)
Formal languages, Chomsky hierarchy, formal computation and machine models, finite automata, pushdown automata, Turing machines, Church's Thesis, Recursively enumerable sets. Diagonal arguments. Reducibility, complexity classes.

CSC 803: Advacnced Computer Algorithms (3 Credit Units)
Review of data structures; linear data structures, hashing, trees, graphs, recursion. Complexity classes; empirical measurements of performance; time and space tradeoffs analysis. Algorithmic strategies: Brute-force algorithms; greedy algorithms; divide-and-conquer; backtracking; branch-and-bound; minimum spanning tree, heuristics; pattern matching and string/text algorithms; numerical approximation algorithms. Tractable and intractable problems.

CSC 804: Software Engineering (3 Credit Units)
Software engineering and its place as an engineering discipline. Life cycle of software system: Requirements analysis, development, operation and maintenance. Software metrics: Portability, Re-usability, Correctness, Reliability, Efficiency, Usability, Integrity, Maintainability and Flexibility. Software quality and testing. Software architecture: architecture description languages, pattern-oriented software architecture, component-based development, distributed software architecture using middleware, enterprise application integration, architecture for mobile and pervasive systems and model driven architecture. Advanced modelling: UML extension mechanisms, object constraint language and model checking. Software project management: Study of interpersonal process decision making styles, problem solving concepts and procedures, creative effort, conflict resolution, leadership and assessment. Concepts of motivation, team work and group dynamics. Software engineering and law: intellectual property law, professional ethics and code of conduct. Patents, trademarks, copyright, trade secrets, privacy and confidentiality, contracts and licensing, government regulations, global legal issues including Internet law and cyber crime. Overview of Open Source Software.

CSC 805: Computer Networks (3 Credit Units)
Channels and channel capacity; introduction to information theory; sharing network resources: telecommunication history; circuit switching and packet switching; multiplexing; FDM, TDM, statistical multiplexing; virtual circuits and datagrams; advantages and disadvantages; sharing the medium: Aloha, CSMA (persistent and non-persistent), CSMA-CD, token passing, CDMA, wireless LANs and simple performance analysis; dealing with errors: errors, coding and redundancy; hamming theory and codes; CRCs, ARQ protocols; CR selective retransmission and flow control; internetworking and the internet: ISPs, datagram forwarding; the DNS; IPv4; addressing and forwarding; encapsulation and address resolution; TCP and UDP; ports and congestion controls; example applications; modelling data networks: services and protocols; layered architectures; the OSI 7-layer model; introduction to queue theory; physical media; LANs and bridging; WANs and point-to-point links; routing; addressing and routing in the internet; end-to-end communication in the internet; and application protocols. Cyber space technology: Cyber Crime, Cyber Security and models of Cyber Solution.

CSC 806: Object Oriented Programming (3 Credit Units)
Procedural programming and its limitations. Software development methodology: Fundamental design concepts and principles; structured design; testing and debugging strategies; test case design; programming environments; testing and debugging tools. Basic concepts and formal methods of Object Oriented Programming (OOP). Study of the features of a popular Object Oriented Programming Language such as JAVA, Visual Basic and C++. Applications of OOP in systems software development.

CSC 807: Advanced Computer Graphics (3 Credit Units)
Prerequisite: Knowledge of C.
Reflection models. Texture and models, texture and environment mapping, advanced ray tracing, radiosity method, volume rendering, advanced modelling techniques, simulation and animation.

CSC 808: Advanced Computer Architecture (3 Credit Units)
Advanced computer architecture including discussion of instruction set design (RISC and CISC), virtual memory system design, memory hierarchies, cache memories, pipelining, vector processing, I/O subsystems, co-processors, and multiprocessor architectures. Case studies of current systems. Prerequisite: U.G. Computer Architecture.

CSC 809: Database Systems (3 Credit Units)
A brief introduction to database concepts: file systems and databases, and the relational database model; design concepts and implementation: entity relationship (E-R) modelling; normalisation of database tables and structured query language; database design and implementation. Transaction management and concurrency control and distributed database management systems; database privacy, security, failure and recovery. Object-oriented databases; client/server systems; data warehouse; data mining; databases in electronic commerce; web database development and database administration.

CSC 810: Artificial Intelligence (3 Credit Units)
Introduction to basic programming techniques of artificial intelligence (AI). Domain analysis; representation of Knowledge and strategies; control on inference and search; development of interactive intelligence CAI programs; the role of analogical reasoning. The main contents are symbol manipulations and AI problem solving techniques. Topics include LISP primitives, LISP objects and evaluation, recursion and iteration and data abstraction (association lists, properties and DESTRUCT), macros, object – centred programming, symbolic pattern matching and basic solving methods.

CSC 811: Expert System (3 Credit Units)
Review of Artificial Intelligence and its place in experts systems. Introduction to expert systems and expert support system. Characteristics of experts systems. Knowledge-based systems. Types of expert systems.

CSC 812: Operations Research (3 Credit Units)
Introduction to operations research. Treatment of some of these topics and the applications of computer in their solution: Decision Theory, Game Theory, Inventory Control, Linear Programming Problems (Simplex Method of solution), Transportation Problems, Assignment Problems, Project/Network Analysis, Forecasting, Queuing Theory, Simulation.

CSC 813: Compiler Design And Construction (3 Credit Units)
Anatomy of a compiler; lexical analysis (scanning); syntax analysis (parsing); syntax-directed translation; semantic analysis, intermediate code generation; code generation and optimisation. Advanced topics include garbage collection; dynamic data structures, pointer analysis, aliasing; code scheduling, pipelining; dependence testing; loop level optimisation; superscalar optimisation; profile-driven optimisation; debugging support; incremental parsing; type inference; advanced parsing algorithms; practical attribute evaluation; function in-lining and partial evaluation.

CSC 814: Advanced Topics In Computer Science (3 Credit Units)
Quick review of the fundamental technologies: parsing, bytecodes, interpretive systems in general, and run-time support, especially memory management. Analysis and classification of existing embedded languages according to the language paradigms used and the features included, without reference to the implementations. Analysis of the implementations of existing embedded languages. Review and study of topical issues and current development in the area of Computer Science.

CSC 815: Internet Technology (3 Credit Units)
Introduction to Internet, standards and specifications; survey of contemporary Internet technologies; Current Internet tools; Designing and publishing a web server; WWW programming Markup languages; Using alternative protocols in WWW, Adding multimedia features to WWW; Server side programming, client programming and database programming for the web; Security and Privacy.

CSC 816: Human Computer Interaction (3 Credit Units)
Positive and negative effects of the computers and ICT on human beings and societies. Computing as a profession, organization using computers, sociological impacts of computers, individuals and computers, computer as an audit tool, computers in banking, computer based information systems and telecommunications, computers in consultancy services, design and construction, education, government insurance, stock-brokerage, legal and medical professions.

CSC 817: Digital Signal Processing (3 Credit Units)
Introduction; brief review of analogue and digital signal processing systems; discrete time linear time-invariant signal processing systems; design of finite impulse response digital filters; introduction to z-transforms and infinite impulse response type discrete time filters; design of infinite impulse response type digital filters using analogue filter approximations; digital processing of analogue signals and other data; introduction to the discrete Fourier transform.

CSC 818: Introduction To Quantum Computation (3 Credit Units)
The theory of quantum information and quantum computation; classical information theory, compression of quantum information, transmission of quantum information through noisy channels, quantum entanglement, quantum cryptography; classical complexity theory, quantum complexity, efficient quantum algorithms; quantum error-correcting codes, fault-tolerant quantum computation; and physical implementations of quantum computation.

CSC 819: Mobile And Adaptive Systems (3 Credit Units)
Introduction and overview; properties of wireless; PANs, LANs and WANs: Ad-hoc and infrastructure networks; physical constraints and limitations (transmission and reception), network structures and architectures, including hand-off and mobility support at the physical/link level; example technologies at the physical/link layers: PANS – bluetooth, LANs – IEEE802.11, HiperLAN, basic GSM and GPRS network structures and protocol architectures, next generation wireless overview including UMTS, IMT-2000 and W-CDMA; mobile IP: mobile IPv4 and mobile IPv6, problems with routing, quality of service and security; overview of use of intelligence in mobile systems and power management issues; file systems: CODA and the like and mobile infrastructure support. Adaptive and re-configurable systems, mobile multimedia and its relationship to proxying, context sensitive applications, ubiquitous computing, pervasive computing and ambient networking, overlay networks and vertical hand-offs, programmable networking and applications for mobile systems, code mobility and control/signalling.

CSC 820: Electronic Commerce Technologies (3 Credit Units)
Introduction; the sociology and psychology of electronic commerce: building, recognising, managing and making use of online communities in web-based environments, theories of online presence and cooperation; a guide to e-commerce in general: how to differentiate e-commerce today from e-commerce yesterday, current problems of e-commerce and interesting solutions and approaches to those problems; a guide to knowledge commerce: understanding knowledge as a commodity and as a process, and representing it in web-based environments; web architecture: structural design of e-commerce systems, client-server architecture, 2-, 3-, n-tier design, server farms, scalability, integration of legacy systems, Java beans, Enterprise Java beans and java server pages, particular problems posed by 24/7 operation and an open user community; data interchange: exchanging data over the internet, XML, style sheets, document type definition, metadata and document discovery, interchange of processes using WSDL and SOAP as examples; usability: user-interfaces design for websites, use of human computer interaction methodologies in evaluating user interfaces; electronic payments: technologies that support the processing of electronic payments, characteristics and properties of electronic payment systems; mass personalisation and the virtual customer: automation of the customer relationship, use of data to customise the web experience, cookies and their risks, rule-based filtering, implicit profiling, collaborative filtering.

CSC 821: Bioinformatics (3 Credit Units)

Study of Forensics: Principles and practice of identification; Pattern matching and recognition. Computer Forensics: pattern recognition, data mining, machine learning algorithms, and visualization. Sequence alignment, applications to biological sciences – DNA, gene finding, genome assembly, drug design, drug discovery, protein structure alignment, protein structure prediction, prediction of gene expression and protein-protein interactions, genome-wide association studies and the modelling of evolution.

CSC 822: Designing Complex Software Systems (3 Credit Units)

Designing new computational systems and the software that drives them is both hard and interesting. One important style of computer science research, often called experimental systems research, revolves around such design activities. Research in this style seeks to advance our understanding of, and our ability to create, general computer systems that support the development and use of more domain-specific applications.

CSC 823: Computer Organization (3 Credit Units)

Study of representative digital computer organization with emphasis on control unit logic, input/output processors and devices, asynchronous processing, concurrency and parallelism. Memory hierarchies.

CSC 824: Programming Languages (3 Credit Units)

Comparative study of the organization and implementation of a variety of programming languages and language features. Design principles are explored and applied in a historical review of major languages. Procedural, functional, logic-based, object-oriented and parallel languages. Research issues such as polymorphism, formal semantics and verification explored in depth.

CSC 825: Digital Picture Processing (3 Credit Units)

Basic concepts of image formation and image analysis: imaging geometry, sampling, filtering, edge detection, Hough transforms, region extraction and representation, extracting and modeling three-dimensional objects. Students will be assigned analytical and programming assignments to explore these concepts.

CSC 826: Artificial Intelligence (3 Credit Units)

In depth study of a few major areas historically considered to be part of artificial intelligence. In particular, detailed coverage will be given to the design considerations involved in the following applications: automatic theorem proving, natural language understanding and machine learning.

CSC 827: Advanced Computer Vision (3 Credit Units)

Analysis of advanced topics in automated reconstruction of imaged objects and computer interpretation of imaged objects; techniques for three-dimensional object reconstruction; computing motion parameters from sequences of images; computational frameworks for vision tasks such as regularization, and stochastic relaxation; approaches for autonomous navigation. Depth image analysis; novel imaging techniques and applications; and parallel architectures for computer vision.

Areas of Specialization in Computer Science

i. Computer Science Theory/Foundation of Computer Science
ii. Computer Systems
iii. Software Engineering
iv. Database Systems/Data Engineering
v. Computer Communications and Networks
vi. Artificial Intelligence
vii. Computer Forensics
viii. Human Computer Interactions

9 GEOLOGY

9.1 Master's Degree in Geology

General Compulsory Courses

SCI 801	Management and Entrepreneurship	(2 Credit Units)
SCI 802	ICT and Research Methodology	(2 Credit Units)

Other Core Courses

GLY 801	Research Seminar in Geology	(2 Credit Units)
GLY 802	Research project in Geology	(6 Credit Units)
GLY 803	Methodology of Geological Research	(3 Credit Units)
GLY 804	Photogeology and Remote Sensing	(2 Credit Units)
GLY 805	Hydrogeochemistry	(3 Credit Units)
GLY 806 – Groundwater Geophysis and Geotechnical problems		(3 Credit Units)
GLY 807 – Field Mapping in Mineral Exploration		(2 Credit Units)

Elective Courses

Sedimentary/Petroleum Geology

GLY 808 – Advanced Micropaleontology	(3 Credit Units)
GLY 809 – Advanced Sedimentary Petrology	(2 Credit Units)
GLY 810 – Subsurface Geology	(3 Credit Units)
GLY 811 – Advanced Structural Geology	(2 Credit Units)
GLY 812 – Advanced Stratigraphic Analysis	(2 Credit Units)
GLY 813 – Reservoir Geology and Petroleum Engineering	(2 Credit Units)
GLY 814 – Clay Mineralogy	(3 Credit Units)
GLY 815 – Exploration Geophysis	(3 Credit Units)

Engineering Geology/Hydrogeology Specialisation

GLY 816 – Advanced Engineering Geology	(2 Credit Units)
GLY 817 – Advanced Hydrogeology	(2 Credit Units)
GLY 811 – Advanced Structural Geology	(2 Credit Units)
GLY 818 – Soil and Rock Mechanics	(3 Credit Units)
GLY 815 – Exploration Geophysics	(3 Credit Units)
GLY 819 – Applied Hydrogeology	(2 Credit Units)

Applied Geophysics Specialisation

GLY 820 – Gravity and Magnetic Methods	(3 Credit Units)
GLY 821 – Seismic and Well Logging Methods	(3 Credit Units)
GLY 822 – Electrical and Radiometric Methods	(3 Credit Units)
GLY 815 – Exploration Geophysics	(3 Credit Units)
GLY 810 – Subsurface Geology	(3 Credit Units)
GLY 812 – Advanced Structural Geology	(2 Credit Units)
PHI 805 – Numerical and Computational Methods	(3 Credit Units)

9.1.1 Details of Courses

GLY 801 Research Seminar In Geology (2 Credit Units)

Literature study, writing up and oral presentation of a topic on an aspect of the area of specialization as approved by the Department.

GLY 802 Research Project (6 Credit Units)

Special geology investigation, with the report including results and interpretation being presented dissertation.

GLY 803 Methodology Of Geological Research (3 Credit Units)
Definition, Spectrum and types of Research, Development of conceptual framework in Geological Research, Preparing a Research Proposal Approach to Geological problems; Systematic collection of field and laboratory data. Statistical analysis. Geo-writing and referencing. Ethics in Research. Common errors in Research process. Publishing Research. Scientific Creativity.

GLY 804 Photogeology And Remote Sensing (2 Credit Units)
The Physics of various remote sensing techniques : interpretation of conventional aerial photography, infra-red remote sensing techniques side-looking air-borne; theory and applications of landsat imagery, enhancement techniques for satellite imagery.

GLY 805 Hydrogeochemistry (3 Credit Units)
Basic thermodynamics, chemical equilibra in association and complexing, oxidation reduction reactions. EI-PH Concept. Interaction of groundwater with porous media, geochemical evolution along flow systems, hydrochemical models.

GLY 806 Groundwater Geophysics And Geotechnical Problems (3 Credit Units)
Application of surface and sub-surface geophysical methods to groundwater exploration; applications to pollution plumes delineating surface – Sub-Surface geology methods. Pore pressure and effective stress concepts and their application to slope stability analysis. Effects of excessive withdrawal of groundwater. Groundwater and dams, foundations, groundwater inflows into tunnels and excavations. Surface and groundwater flow systems as factors of soil and gully erosion

GLY 807 GEOLOGICAL Field Mineral Exploration (3 Credit Units)
Field training techniques of geological investigation; as exemplified in mineral exploration, including geological, geophysical, geotechnical hydrogeological and geochemical methods. Field assignment and write-up of concise technical report.

GLY 808 Advanced Micropaleontology (3 Credit Units)
Definition and practical value of micropaleontology, Historical review of micropaleontology Development of Commercial Micropaleontology. Physical, Chemical and Biological factors of the non- marine and marine environments and their effects on micro-organisms Environmental distribution of micro-organisms. Evolutionary and phylogenetic relationships within groups of micro-fossils. Ecology and paleoecological relationships or living morphological (particularly diagnostic) features of biostratigraphically and paleoecologically important taxa of foraminifera and ostracoda.

GLY 809 Advanced Sedimentary Petrology (3 Credit Units)
Petrology origin, composition, texture and classification of carbonates, evaporates, Cherts, phosphases, iron-rich rocks and manganese deposit. Limestone diagenesis and dolomitisation. Textures, structures, mineralogy and chemical composition of terri terrigenous classtics; classification of sandstones, quartz types and origin. Relation of sandstone petrography to tectonics and sedimentation; diagenesis. Field and laboratory methods of study of sedimentary rocks x-ray analytical techniques.

GLY 810 Sub Surface Geology (3 Credit Units)
Subsurface data acquisition, drilling, coring, logging, fluid sampling and seismic surveys. Petrophysics, reservoir characteristics and geology. Construction and interpretation of subsurface maps, Cross-sections and panel diagrams; Seismic stratigraphic data processing and interpretations, special topics and problems, criteria for identifying subsurface faulting. Basin analysis.

GLY 811 Advanced Structural Geology (2 Credit Units)
Stress in 2-dimensions, trajectories, Moh diagram. Strain in 2 and 3 dimensions, Rheology, stress-strain relations of elastic, viscous and visco elastic materials. Geometric techniques of structural

analysis. Projection techniques. Fracture analysis. Mapping techniques. Geotectonics, crustal morphology, word patterns, theories of orogensis.

GLY 812 Advanced Stratigraphic Analysis (2 Credit Units)
Principles of Stratigraphy, Types areas, boundary problems, Correlation, Stratigraphic nomenclature, Biostratigraphy and biostratigraphic refinement with emphasis on African examples.

GLY 813 Reservoir Geology And Petroleum Engineering (2 Credit Units)
Clastic reservoir rocks and porosity types, Formation Evaluation-logs and log interpretations. Oil-field Waters; subsurface pressures. Operations related to drilling and completing a well – coring and sidewall sampling, casing, drilling time and drill stem tests, Geological factors affecting choice of techniques and completion operations. Fundamentals of fluid – permeated rocks – Porosity and permeability. Darcy Equation. P-V-T relationship and use condensate reservoir. Mechanisms controlling oil production. Calculation of Oil and Gas in place including the material balance techniques.

GLY 814 Clay Mineralogy (2 Credit Units)
Study of types of Clay minerals; techniques for clay minerals determination, X-ray, D.T.A. Microscope, Environments of Clay mineral and diagenesis. Applied Clay mineralogy and industrial application

GLY 815 Exploration Geophysics (3 Credit Units)
Role of geophysics in mineral exploration. Basic physical lans, properties of rocks and minerals, instruments, field procedure, data acquisition, reduction and interpretation relating to gravity, magnetic, self potentials, resistivity, induced polarization, electromagnetic, seismic reflection and refraction, and radioactivity methods, Geophysical well logging. Applicability of various methods, field examples, relative cost and survey planning.

GLY 816 Advanced Engineering Geology (2 Credit Units)
Exploitation of building subsoils. Open cuts and retaining walls. Foundation slopes and their stability. Engineering geological maps and their evaluation. Mining and tunneling – Theory and methods. Dams – types design and construction. Elements of a road pavement. Site investigation in engineering practice. Rock as a construction material. Laterite soils and black cotton soils – Distribution and nature, physical characteristics, chemistry and mineralogy. Structure and Engineering properties.

GLY 817 Advanced Hydrogeology (2 Credit Units)
Occurrence of groundwater, Groundwater recharge as part of hydrological cycle, Ground water and well hydraulics. Exploration for groundwater – remote sensing, geological and geophysical methods, Groundwater extraction – Perforation methods. Well completion, Well Development. Pumping Test. Water quality and purification. Artificial recharge of groundwater, salt-water intrusion in coastal aquifers. Problems of water resources planning and management in Nigeria.

GLY 818 Soil And Rock Mechanics (3 Credit Unit)
Engineering classification of rock and soils. Weathering and weathering factors. Weatherability of minerals. Soil types. Structures and textures in rocks and soils. Clay minerals types, structures, identification and influence on soil properties. Stress and strain in 2 and 3 dimensions. Representation of stress and strain. Theories of elasticity and plasticity. Stress fields and their measurements, criteria of failure and yield. Classification of soils. Flow of water in soil – steady state and transient conditions. Shear strength and its measurement. Limiting conditions in a semi-infinite space. Soil properties and their measurement. Earth pressures. Bearing capacity. Physical Properties of rock. Measurement of Stress/Strain in the laboratory and in the field. Planes of weaknesses.

GLY 819 Applied Hydrogeology (2 Credit Units)
Introduction to open channel flow – Chezy's and manning formulae. Tabular and laminar flow. Hydrological cycle – precipitation, evapotransporation, infiltration, Run off measurement of flow. Hydrograph analysis. Hydrological forecasting. Choice of dam sites and safety consideration of slopes. Drainage characteristic of Nigerian Rivers. Erosion problems in Nigeria.

GLY 820 Gravity and Magnetic Methods (3 Credit Units)
Ambiguity in interpretation and conditions for uniqueness. Resolution of anomalies. Limiting formulas. Gravity and magnetic effects of simple geometrical forms, depth rules, geometrical constructions and integral transforms, computation of gravity and magnetic anomalies for irregular bodies. Regional, residual and derivatives. Upward and downward continuation and their uses. Frequency domain analysis. Poisson's relation between gravity and magnetic fields. Field examples.

GLY 821 Seismic And Well Logging Methods (3 Credit Units)
Generation, propagation, reception and recording of seismic pulses, operation of refraction and reflection surveys. Data acquisition, reduction and processing velocity determination, preparation of time and geological sections. Case studies in seismic surveys
Types of logs and information obtainable from them. Self potential, induction, resistivity, Sonic and Cement band, radiation, temperature, micro-resistivity and others. Quantitative log interpretation and determination of rock parameters.

GLY 822 Electrical And Radiometric Methods (3 Credit Units)
Electrical properties of earth material. Self potential and resistivity methods (theory, instruments, array systems, sounding and profiling and depth of investigation) . Induced polarization methods in time and frequency domains. Electromagnetic methods (Magneto-telluric, dipole-dipole. Turam, large loop, transient and continuous wave, airborne etc). Applicability and field examples. Radioactive decay and equilibrium. Radioactivity of rocks, Geiger and Scintillation Counters. Grammray spectrometers. Ground and airborne survey procedures. Field examples.

10 GEOPHYSICS

The Postgraduate programme in Geophysics provides advanced training in the application of physical principles to the solution of practical problems related to the search for minerals of economics importance, groundwater/hydrogeology, and engineering geology.
A multidisciplinary approach to the solution of problems is encouraged, and graduates of geophysics, geology, physics, and mathematics and engineering are encourage to apply for postgraduate work in geophysics.

Students without appropriate exposure to the earth sciences must take remedial course(s) to acquire the necessary working background.

Core Courses
General

SCI 801	-	Management and Entrepreneurship	(2 Credit Units)
SCI 802	-	ICT and Research Methodology	(2 Credit Units)
GPY 801	-	Physics of the Earth's Interior	(3 Credit Units)
GPY 802	-	Time Series Analysis and Data Processing	(3 Credit Units)
GPY 803	-	Bore-Hole Geophysics	(2 Credit Units)
GPY 804	-	Research Seminar in Geophysics	(2 Credit Units)
GPY 805	-	Research Project in Geophysics	(6 Credit Units)
GPY 806	-	Gravity and Magnetic Methods	(3 Credit Units)
GPY 809	-	Geophysical Field Work	(1 Credit Unit)

Elective Courses

GPY 807	-	Seismic Methods	(3 Credit Units)
GPY 808	-	Electrical and Electromagnetic Methods	(3 Credit Units)
GPY 810	-	Radiometric Methods	(2 Credit Units)
GPY 811	-	Instrumentation	(2 Credit Units)
GPY 812	-	Digital Filter Theory	(2 Credit Units)
GPY 813	-	Principles of Paleomagnetism	(2 Credit Units)
GPY 814	-	Modelling in Geophysical Prospecting	(2 Credit Units)
PHY 805	-	Numerical and Computational Methods	(3 Credit Units)

Elective Courses (Compulsory Supplementary)
(Depends on Background of Student)

GPY 815	-	Geology for non-geologists	(4 Credit Units)
GPY 816	-	Mathematics for Geologists	(3 Credit Units)
GPY 817	-	Geophysical Prospecting	(3 Credit Units)
PHY 802	-	Applied Electronic and Workshop Practice	(3 Credit Units)
PHY 803	-	Electromagnetic Theory	(3 Credit Units)

Course Description

GPY 801 Physics of the Earth's Interior (3 Credit Units)
Topics in solid earth geophysics with emphasis on elasticity and thermal state of the earth. Physical and chemical characteristics of the earth. Application of Physics and thermodynamics to earth materials and the use of available observable and laboratory data to derive information about the state of, and processes in the earth's interior. Seismology and the internal structure of the earth. The magnetic field of the earth: main field and time-varying components. Age and thermal state. Geochronology. Geodynamics.

GPY 802 Time Series Analysis And Data Processing (3 Credit Units)
Signal Theory. Continuous and Discrete Fourier series. Convolution integral. Correlation integral. Power spectral analysis. Filtering techniques. Application to geophysical data processing. Practical Examples and Classwork.

GPY 803 Borehole Geophysics (2 Credit Units)
Theories and methods of boreholes geophysics. Well-logging techniques. Log. Interpretation. Exercises.

GPY 804 Project Seminar In Geophysics (2credit Units)
Literature Study, Writing up and oral presentation of a topic on an aspect of the area of specialization.

GPY 805 Research Project In Geophysics (6 Credit Units)
Special geophysical in investigation with the report including results and interpretation being presented dissertation.

GPY 806 Gravity And Magnetic Methods (3 Credit Units)
Ambiguity in interpretation and conditions for uniqueness. Resolution of anomalies. Limiting formulae. Gravity and magnetic effects of some simple models. Anomaly characteristics, depth rules, geometrical constructions, and use of integral transforms computation of gravity and magnetic anomalies for irregular bodies. Regional, residual and vertical derivatives. Upward and downward continuation, and their uses. Poissons relation between gravity and magnetic potential. Magnetic reduction to pole. Remanent magnetication in magnetic interpretation. Frequency domain analysis.

GPY 807 Seismic Methods (3 Credit Units)
The propagation of elastic wave through solids. The effect of boundaries between different media. The Raypath method. Detection of ground motion and the theories of mechanical and electrical seismographs. Advance refraction techniques to exploration. Data acquisition in modern reflection practice sources: Explosive and implosive, airgun, sparker and others. Recording system: Source and detector arrays VIBROSETS. Marine seismic methods. Seismic signal Analysis . Refraction Seismic interpretation. Specialized interpretation techniques of reflection seismic data (land and sea). Velocity Spectra, Velocity determination. Static Migration. Synthetic Seismogram technique. Industrial seismic Data processing.

GPY 808 Electrical And Electromagnetic Methods (3 Credit Units)
Advanced electrical resistivity (E.R). Self-potential (S.P) and the induced polarization techniques of geophysical prospecting . Data collection, Correction and consideration of specialized interpretation technique. Application of the electrical methods in geological mapping, mineral investigation, engineering site investigation, groundwater and geothermal energy investigations.
Electromagnetic theory; Description of EM fields. Combination of fields. Amplitude and phase relations, Mutual Inductance. Ground Electromagnetic processing methods; Tilt (or Dip) Angle Methods, VLF and AFMG-Field Techniques and Interpretation : Types curves and phasor (Argand) diagrams. Airborne EM methods; Quardrature methods. Long wire system; AFMAG, VLF and Input methods. Field and Data interpretation procedures.

GPY 809 Geophysical Field Work (1 Credit Unit)
Each student will work on a given problem using combined geophysical techniques.

GPY 810 Radiometric Methods (2 Credit Units)
Principles of radioactivity, Radioactivity of rocks and minerals ionization chamber Geiger – Muller counter; Scintillation meter; Miscellaneous instrument and calibration. Field techniques. Spectrometric Surveys. Aero-spectrometric methods. Interpretation procedures.

GPY 811 Instrumentation (2 Credit Units)
The development and modification of Geophysical Instruments.

GPY 812 Digital Filter Theory (2 Credit Units)
Signal Theory. Theory of Discrete - Time Linear Systems, Convolution, Correlations, Special Analysis: Transforms, Power Spectral Analysis, Filtering techniques, Statistical methods. Application to Geophysical Data Processing.

GPY 813 Principles Of Paleomagnetism (2 Credit Units)
Detrital Magnetization, Thermo-remanent magnetization, Collection and treatment of Data, magnetic cleaning, measurement of natural remanent magnetization, Investigation of other magnetic properties of rocks Temperature effects, stereographic projection. Application of results of paleomagnetism.

GPY 814 Modelling In Geophysical Prospecting (2 Credit Units)
Modelling conditions, modelling parameters. The resistivity model tank, magnetic response modelling. Electromagnetic scale modelling. Applications of modelling to geophysical interpretation.

GPY 815 Geology For Non-Geologists (4 Credit Units)
Introduction to the basic principles of stratigraphy Applied physical stratigraphy. Introduction Structural Geology and interpretation for potential mineral resources. Simple geological structures, interpretation of folds, faults and fractures. Basic map reading, photo-geology and interpretation, Introduction to petrology; Igneous, metamorphic and sedimentary. Mineral deposits, their geology and uses. Identification of various rock types and their composition, Economic geology: Geology of petroleum; Oil accumulation and nature, Origin of Oil, Migration and accumulation of Oil, Discussion of various traps and salf Domes, Basic concepts of Hydro/Engineering Geology and Marine Geology.

GPY 816 Mathematics For Geologists (4credit Units)
Limits Continuity and differentiability. Mean Value Theorem, maxima and minima. Error Analysis and Leas of Squares Techniques Vector Analysis, Differentiation of a vector, sequencies and series, Fourier series volume integrals. The Fourier and Laplace Transforms. Solution of laplaces equation Spherical Harmonic Analysis, Polynomial Surface and their computation.

GPY 817 GEOPHYSICAL Prospecting (3 Credit Units)
Gravity and Magnetic methods, Electrical methods, Seismic Method, Electromagnetic method. Radiometric methods.

11 MATHEMATICS

Master's Degree In Mathematics

Areas of Specialization

a) Pure Mathematics
b) Applied Mathematics

Core Courses

Generic Core Courses

SCI 801: Management and Entrepreneurship	(2 Credit Units)
SCI 802: ICT and Research Methodology	(2 Credit Units)

Programme Core Courses

MAT	800	Research Project	(6 Credit Units)
MAT	801	Algebra	(3 Credit Units)
MAT	802	Topology	(3 Credit Units)
MAT	803	Real Analysis	(3 Credit Units)
MAT	804	Complex Analysis	(3 Credit Units)
MAT	805	Partial Differential Equations	(3 Credit Units)
MAT	824	Seminar	(2 Credit Units)

Elective Courses

A) For Pure Mathematics

MAT	806	Group Representation Theory	(3 Credit Units)
MAT	807	Number Theory	(3 Credit Units)
MAT	808	Category Theory	(3 Credit Units)
MAT	809	Lie Groups	(3 Credit Units)
MAT	810	Differential Manifolds	(3 Credit Units)
MAT	811	Theory of Integration	(3 Credit Units)
MAT	812	Integral Equations	(3 Credit Units)
MAT	813	Theory of Distributions	(3 Credit Units)
MAT	814	Introduction to Mathematical Modelling	(3 Credit Units)

B) For Applied Mathematics

MAT	815	Quantum Mechanics 1	(3 Credit Units)
MAT	816	Fluid Mechanics	(3 Credit Units)
MAT	817	Elasticity	(3 Credit Units)
MAT	818	Electromagnetic Theory	(3 Credit Units)
MAT	819	Quantum Mechanics 11	(3 Credit Units)
MAT	820	Visco – Elasticity and Plasticity	(3 Credit Units)
MAT	821	Control Theory	(3 Credit Units)
MAT	822	Finite Elements Methods	(3 Credit Units)
MAT	823	Biomathematics	(3 Credit Units)

MAT 801 Algebra (3 Credit Units)

Sylow theorems, direct products, fundamental theorem of finite Albelean groups, field of quotients, Euclidean rings, Polynomial rings over commutative rings, inner product spaces, theory modules, sub-modules, quotient modules, modules over principal idea domains. Applications finitely generated Albelean group fields extension fields elements of Galois theory, solvability radicals.

MAT 802 Topology (3 Credit Units)
Review of categories and functors. Homology, fundamental group, covering transformation, simplicial complexes. Singular homology, Universal co-efficient theorem for homology and cohomology. Spectral sequence.

MAT 803 Real Analysis (3 Credit Units)
Measures and Integration. Outer measure. Lesbegue Measure. Basic properties of Banach and Hilbert spaces. Operators, Duality. Basic theorems in functional analysis. Classical Banach spaces. Spectral theory of Operators in Hilbert spaces. L_2 – space as a Hilbert space. Banach algebras. Gelfand theory, compact operators. Examples and applications to classical analysis.

MAT 804 Complex Analysis (3 Credit Units)
Periodic functions, Weierstrass functions, elliptic curves. Modular forms. Algebraic functions, Riemann surfaces. Covering surfaces, covering transformations. Discontinuous groups of linear transforms, automorphic forms.

MAT 805 Partial Differential Equations 1 (3 Credit Units)
Basic examples of linear partial differential equations and their fundamental equations and their fundamental solutions. Existence and regularity of solutions (Local or Global) of the Cauchy problems; boundary value problems and mixed boundary value problems. The fundamental solutions of their partial differential equations.

MAT 806 Group Representation Theory (3 Credit Units)
Representations of groups by linear transformations; group algebras, character theory and modular representations. Representation theory of algebraic groups; representation of finite groups; representation of compact and locally compact groups; representation of Lie groups. Unitary representation theory.

MAT 807 Number Theory (3 Credit Units)
Algebraic integers. Completions, the different and discriminant. Cyclotomic fields. Parallelotopes. Class-Number. Ideles and Adeles. Elementary properties of Zeta-functions. L-functions.

MAT 808 Category Theory (3 Credit Units)
Categories, functions natural-transformation. Functor categories, limits. Products and corproducts. Pushbacks and Pushouts, adjoing functors. Normal and exact categories: Abelian categories, quotient categories.

MAT 809 Lie Groups (3 Credit Units)
Lie groups and their Lie algebras, subgroups. Martrix groups: One-parameter groups, exponential map, Campbell-Hausdorff formula, Lie algebra of a matrix group, integration on matrix groups. Abstract Lie groups.

MAT 810 Differentiable Manifolds (3 Credit Units)
General Manifolds. Topics such as smooth mappings. Immersions, submersions, transversality, intersection theory, vector fields of manifold; orientation of manifolds: Gausian curvature, Riemannian manifolds, differential forms, integration on manifolds tensors and connections are included.

MAT 811 Theory Of Integration (3 Credit Units)
The theory on closed and bounded intervals: Gauges and integrals. Basic properties of the integral, The fundamental theorems of calculus. The Saks-Henstock Lemma. Measurable functions. Absolute integrability. Convergence theorems. Integrability and mean Convergence. Measure, measurability and multipliers. Mode of Convergences, substitution theorems. Applications. The theory on infinite intervals: General insight into integration on infinite intervals.

MAT 812 Integral Equations (3 Credit Units)
Basic existence theorems: Equations with L_2 kernels: Fredholm Theory; Nonlinear equations, Schauder fixed point theorem. Dual integral and series equations. Wiener-Hope equations and Technique. Singular Integral equations. Applications.

MAT 813 Theory Of Distributions (3 Credit Units)
Topological vector spaces and generalized functions; Distribution calculus and topology; convolution; Tempered distributions and their Fourtier transforms. Integral transforms of Mathematical Physics. Application.

MAT 814 Introduction To Mathematical Modelling (3 Credit Units)
Mathematical Modelling. The Art of Trasnforming Real Life Situation into Mathematical statements. Examples will be drawn from Areas such as Biology, Business, Deformable Media, Industry, and other dynamical system. Case studies.

MAT 815 Quantum Mechanics 1 (3 Credit Units)
Background of the axiomatic approach to Nul et al. Axioms of continuum and Basic Concepts. Constitutive Relations. Equations of Motion and other Equations. Equations of Motions and other Equations of Balance. The place of the Classical Theories.

MAT 816 Fluid Mechanics (3 Credit Units)
Thermodynamics Compessible flow; waves; sheeks; supersonic flow; Boundary layer Theory; stability; Turbulance.

MAT 817 Elasticity (3 Credit Units)
Formulation of the Linear Theory; General Theorems; Plane Strain and generalised Plane stress; Ary's solution: Papkovich – Neuber representation; Basic singular solutions; Boundary-value and Boundary-initial value problem.

MAT 818 Electromagnetic Theory (3 Credit Units)
Maswell's Equations; Electromagnetic Potentials: Tensor Calculus; Stress and Energy; Electro Static and Magnetostatics, plane Waves, cylindrical and Spherical waves; Boundary Value Problems; Relativistic Kinmatics and Lorentz Transformation: Electrodynamics.

MAT 819 Quantum Mechanics II (3 Credit Units)
Schrodinger equations; Stone's Theorem and its applications. Unitary transformations: Heisenberg representation: Measurement: Quantum Theory of Scattering; Angular Momentum. Motion in an external field; Base and Fermi Statistics: Perturbation Theory.

MAT 820 Visco-Elasticity And Plasticity (3 Credit Units)
Characteristics of various visco-elastic and Plastic material, Basic equations. Boundary Value Problems. Elastic-plastic problem.

MAT 821 Control Theory (3 Credit Units)
Dynamical Systems in the State Space. Reachability. Stabilizability and Detectability. Equivalence of Contollability and Pole Assignability. The Calculus of Variations. Generalized Huygen's Principle. The Algebraic Riccati Equation. Lyapunov Stability. Applications to Economic Stabiliztion. Planning. Manpower Development. Resource Allocation under Constraints, etc Case Studies.

MAT 822 Finite Element Methods (3 Credit Units)
Introduction to the Finite Element Method: Formulation of the Finite Element Method using the Principle and Virtual Displacement. General Isoparametric Formulation, and Variational Techniques. Generalization of the theory. Application of the Finite Element Method to the Solution

of Engineering Problems e.g., in Solid Mechanics. Heat Transfer. Fluid Dynamics and Mass Transfer. Development of appropriate Computer Programme. Case Studies.

MAT 823 Biomathematics (3 Credit Units)

Mathematical Methods of Deterministic or Stochastic aspects of Biological Systems e.g., Population dynamics, species interaction malaria epidemic, etc.

12 MICROBIOLOGY

Areas of Specialization

1. Microbial Biotechnology
2. Medical/Pathogenic Microbiology
3. Environmental Microbiology
4. Food and Industrial Microbiology

SCI	801	Management and Entrepreneurship	(2 Credit Units)
SCI	802	ICTand Research Methodology	(2 Credit Units)

Core Courses

MCB	801	Principles of Fermentation Technology	(3 Credit Units)
MCB	802	Advanced Microbial Physiology and Metabolism	(3 Credit Units)
MCB	803	Advanced Environmental Microbiology	(3 Credit Units)
MCB	804	Advanced Microbial Genetics and Genomics	(3 Credit Units)
MCB	821	Seminar	(3 Credit Units)
MCB	822	Research Project	(6 Credit Units)

Elective Courses **(25 Credit Units)**

MCB	805	Advanced Bacteriology	(3 Credit Units)
MCB	806	Advanced Virology	(3 Credit Units)
MCB	807	Advanced Mycology	(3 Credit Units)
MCB	808	Advanced Microbial Ecology	(3 Credit Units)
MCB	809	Advanced Public Health Microbiology	(3 Credit Units)
MCB	810	Advanced Plant Pathogenic Microbiology	(3 Credit Units)
MCB	811	Plant Virology	(3 Credit Units)
MCB	812	Antimicrobial Agents and Chemotherapy	(3 Credit Units)
MCB	813	Advanced Food Microbiology	(3 Credit Units)
MCB	814	Advanced Soil Microbiology	(3 Credit Units)

Synopsis of M.Sc Courses (Core)

MCB 801 Principles Of Fermentation Technology (3 Credit Units)
Definition and scope of microbial fermentation. History of industrial fermentation processes. Batch and continuous fermentation systems. Solid state fermentation. Products of fermentation: primary and secondary metabolites, microbial biomass and indigenous fermented foods.

MCB 802 Advanced Microbial Physiology And Metabolism (3 Credit Units)
Energy yielding metabolic processes and pathways in microorganisms. Biosynthetic pathways with special reference to nucleic acids, vitamins, proteins, polysaccharides and lipids. Regulation of biosynthetic processes.

MCB 803 Advanced Environmental Microbiology (3 Credit Units)
Dynamics of microbial populations in air, water and soil. Distribution and survival of aerial and aquatic microorganisms. Biogeochemical cycling of nutrients and chemical elements. Application of microbial systems in water purification, waste management and pollution control. Recent advances in biotransformation and bioremediation.

MCB 804 Advanced Microbial Genetics And Genomics (3 Credit Units)
Principles of Gene expression, Recombinant DNA Technology, Applications of Genetic Engineering in Medicine, Industry and Agriculture. Hybridization. Polymerase Chain Reaction and Microarray Techniques. Maping of prokaryotic genomes e.g E. Coli genomes e.g E. coli genomes libraries. SAGE DNA chip technology. Functional genomics computer analysis, proteomics.

Elective Courses

MCB 805 Advanced Bacteriology (3 Credit Units)
Current concepts in the classification of bacteria. Cultural and nutritional studies. Bacterial pathogenicity and emerging diseases. Antibiotic and Drug resistance. Anaerobic Bacteriology. Laboratory diagnosis, chemotherapy and clinical significance of nosocomial and anerobic infections.

MCB 806 Advanced Virology (3 Credit Units)
Biochemistry of viral replication. RND – directed DNA polymerases. Site – specific and general recombination in phage lambda. Assay of viruses. Viral nucleic acid replication. Inhibition of viral replication. Slow virus diseases. Viral interference and interferons. Tumor virology. Viral immunology and pathogenicity. Techniques in viral diagnosis. Human Immunodefficiency Virus (HIV) and AIDS. Management of viral diseases.

MCB 807 Advanced Mycology (3 Credit Units)
Current trends in the classification of fungi. Fine structure of fungi. Mechanism of spore dispersal and germination. Water relations and rythmns of spore liberation. Economic mycology with special reference to food and industry. Mycotic infections and their control. Fungal toxicology

MCB 808 Advanced Microbial Ecology (3 Credit Units)
Ecological relationships amongst microorganisms with special reference to mutualism, competition, synergism and parasitism. Biochemistry of intra and inter-specific interactions. Simulation of microbial environments in continuous culture. Microbiology of extreme environments. Ecology of the rhizosphere, phylloplane and coral reefs.

MCB 809 Advanced Public Health Microbiology (3 Credit Units)
Detailed studies of microorganisms of public health significance in water, food, air and the soil. Mechanism of bacterial and parasitic infections. Epidemiology of communicable diseases and community protection methods.

MCB 810 Advanced Plant Pathogenic Microbiology (3 Credit Units)
Current trends in aetiology of plant diseases. Ecological and epidemiological aspects of fungal, viral and bacterial diseases of plants. Cytological and biochemical changes in plant diseases.

MCB 811 Plant Virology (3 Credit Units)
Purification, extraction and identification of plant viruses using serological and molecular techniques. Classification and nomenclature of plant viruses. Multicomponent viruses, defective viruses, viroids and other virus-like agents. Nature and mechanism of plant viral infections.

MCB 812 Antimicrobial Agents And Chemotherapy (3 Credit Units)
Chemistry of antimicrobial agents in clinical and industrial usage. Synthesis and production of antibiotics in microbial systems. Structure – activity relationships. Antimicrobial therapy of infections diseases. Mechanism of drug resistance. Drug measurement in body fluids.

MCB 813 Advanced Food Microbiology (3 Credit Units)
Detailed chemistry of specific foods. Role of intrinsic and extrinsic factors in microbial deterioration of foods. Microbial food-borne infections and food intoxications. Quality assurance in the food industry. Role of microbial enzymes in the food industry. Food production and processing. Indigenous fermented foods in Africa and Nigeria. Optimization of food processing methods. Use of prebiotics and probiotics in foods.

MCB 814 Advanced Soil Microbiology (3 Credit Units)

Microbioloy and biochemistry of agronomically important soil processes. Decomposition of organic matter such as hemicellulose, cellulose, lignin and fertilizers. Biochemistry of pesticide degradation.

13 PHYSICS

The Core Courses are:

1.	SCI.801	Management and Entrepreneurship	(2 Credit Units)
2.	SCI. 802	ICT and Research methodology	(2 Credit Units)
3.	PHY 802	Mathematical Methods	(3 Credit Units)
4.	PHY 802	Applied Electronic Workshop Practice	(3 Credit Units)
5.	PHY 807	Seminar	(2 Credit Units)
6.	PHY 892	M.Sc. Project	(6 Credit Units)

Any two of the following listed courses:

7.	PHY 803	Electromagnetic Theory	(3 Credit Units)
8.	PHY 804	Quantum Theory	(3 Credit Units)
9.	PHY 805	Numerical and Computation	(3 Credit Units)

Total Compulsory Courses **(24 Credit Units)**

A student must take at least two courses (6Credit Units) in his area of specialization as listed below.To qualify for a degree of Master of Science in Physics, a student must be credited with a minimum of 30 Units.

PHY 801 Mathematical Methods (3 Credit Units)
Functions of complex variable and the properties and consequences of analyticity: techniques of analytical continuation and applications, calculus of residues. Complex integration. 'Systematic' methods of obtaining 'exact' solutions of O.D.E., in closed forms. Local and global analysis of initial and boundary values problems Applications will include solutions of Eigenvalues of schroedinger type equations, the classical Anharmonic oscillator. Introduction to partial differential equation methods of characteristics for solving first order p.d.e. transform methods and application to the solution of initial and boundary value problems.

PHY 802 Applied Electronics And Workshop Practice (3 Credit Units)
Workshop – safety precautions. Basic hand toils and bench work practice. Plain and cylindrical generation of smooth surface using power operated machines. Selection and properties of materials used for construction – metallic and non-metallic. Metal joining devices and adhesives in common use. Soldering techniques and wrap joints. Multi-meters and oscilloscopes. Auto-ranging in measuring instruments. A survey of the use of electronics circuit devices e.g., diodes, transistors including FET, integrated circuits, photocells. Selection, use and care of test instruments. Survey of pick-ups and transducer devices. Basic circuit synthesis and analysis. Pulse circuits. Instrumentation and measuring techniques: impedance matching. Probes – active and input and output impedance using the scope.

PHY 803 Electromagnetic Theory (3 Credit Units)
Electrostatic potential problems. Poission and Laplace's equation method of images, Green's theorem, multiple expansions. Magnetic fields. Stokes theorem, vector potential. Electromagnetic Maxwell's equation. Propagation of electromagnetic waves in different oinized and non-oinized media, phase velocity, group velocity and pulse propagation, attenuation, refraction, energy propagation and transfer, polarization and dispersion. Green function methods, diffraction theory, simple radiating systems, lagrangian derivation of Maxwell's equations and the covariant structure of electromagnetism.

PHY 804 Quantum Theory (3 Credit Units)
Fundamental of quantum mechanics-operators in Hilbert Space, basic axioms, Matrix formulation of quantum mechanisms – state vectors, observables, equations of motion. Approximation methods in quantum mechanics. Many-electron systems. Scattering theory. Relativistic theory.

PHY 805 Numerical and Computational Method (3 Credit Units)

Interpolation schemes, the Lagrangian representation, Aitkin algorithm least square fit. Interactive processes. Solution of linear equations, Gaussian elimination, inversion of matrics. Fourier series and harmonic analysis. Difference equations. Numerical integration and differentiation – Trapezium, Simpson's limitation of size of grid. Solution of ordinary differential equation, step by step methods. Partial differential equation; simple wave propagation forward difference, backward difference, central difference in time, the implicit scheme, conditions for stability; e.g., diffusion equation; hyperbolic equation method of relaxation and other interactive schemes applied to simultaneous equations; ill-conditioned equations. Elliptic equations – interactive methods, spectral series method.

Functional representation, minimization and telescoping. Computer solution of equations.

PHY 806 M. Sc Projects (6 Credit Units)

PHY 807 Seminar (2 Credit Units)

Areas of Specialization available in the Department are:

a) Ionospheric, Space and Radio Propagation Research
b) Meteorology and Physics of the Lower Atmosphere
c) Solid Earth Physics
d) Radiation and Health Physics/Nuclear Physics
e) Solid State Physics
f) Instrumentation/Engineering Physics
g) Theoretical Physics

For a student to be credited with specialization in any of these areas, he must register for additional courses from the following courses in the various fields of specialization.

Elective Courses for Ionospheric, Space and Radio Propagation Research

PHY 808 Ionospheric Physics I (2 Credit Units)

Constitution of the atmosphere. Formation and structure of D-, E-, and F-layers of the ionosphere. Vertical and Oblique propagation of radio waves in the ionosphere. Ionospheric absorption and fading, magneto-ionic theory. Ionospheric disturbances. Special features of the equatorial ionosphere.

PHY 809 Ionospheric Physics II (2 Credit Units)

The earth's magnetic field. Secular and transient variations. Aurorae. Conjugate point relationships. Winds and movements. Rockets and satellites. Other special techniques.

PHY 810 Phenomena In Natural Plasma (3 Credit Units)

Basic concept and common phenomena: Debye shielding, dielectric constant, charge and current densities, conservation laws, dispersion relations in a magneto-plasma. Equations of continuity, diffusion. Equations of motion and transport of ionisation, adiabatic invariants. Collusion, ionization and conductivity. Instabilities in plasma and waves in plasma:. Ionosphere; the earth's ionosphere. Altitude distribution of charged particles. Collisions and conductivity. Plasma instabilities and generation of electron density irregularities such as sporadic E and spread F. Artificial modification of the ionosphere. The ionosphere's of other planets. Magnetosphere: earth's radiation belts. Geomagnetic trapping of solar wind. Ionospheric and magnetic storms. Sun: reactions in the sun, Solar flux and omission of energetic particles.

PHY 811 Structure and Dynamics Of The Upper Atmosphere (3 Credit Units)
Structure and Dynamics of the Upper Atmosphere Atmospheric nomenclature. Hydrostatic equations of atmospheric structure, scale height. Heat balance in the thermosphere, dissociation and diffusion. Production and loss processes of ions and electrons. Chapman theory. Attitude distribution and temporal variations of neutral and ionized constituents, temperature and collision frequency in the mesosphere and thermosphere. Winds and tidal oscillations. Gravity waves. Drift motions of irregularities. E-region clearic current and the dynamics of the ionosphere. Propagation of electromagnetic waves in the ionosphere. Measuring techniques for the parameter of the neutral constituents. Ions and electrons, wind and drifts of irregularities, and temperature with special emphasis on those used locally.

PHY 812 Ionosphere Physics (3 Credit Units)
Constitution of the atmosphere. Formation and structure of D-, E-, and F-layers pf the ionosphere. Vertical and oblique propagation of radio waves in the ionosphere. Ionospheric absorption and fading, magneto-ionic theory. Ionospheric disturbances. Special features of the equatorial ionosphere.

PHY 813 Dynamic Meteorology (3 Credit Units)
Equations and fundamental laws governing atmospheric motion on rotating earth. Orders of magnitude for different scale of motion. The hydrostatic and geotropic approximations. The thermal wind surfaces of discontinuity. Gravity waves, acoustic waves and Rossby waves. Tidal oscillations Transformation of basic equations into pressure coordinates formulation. Vorticity and divergence equations. Kelvins's Bjerkness' theorem, quasi-geostrophic models. The Omega equation. The boundary layer; the Ekman layer and incorporation of friction into quasi-geostrophic models. Map projections. Stable and unstable waves. Introduction to numerical weather forcasting.

Elective Courses for Solid Earth Physics

PHY 814 Structural Properties Of Solid (3 Credit Units)
Crystal structure of solids – fundamental types of lattices, position and orientation of planes in crystals, simple crystal structure, cohesive energy of crystals. Theory of reciprocal lattice and crystal diffraction – scattering from real crystals, systematic absent reflections. Experimental study of crystals diffraction, rotating crystal method. Laue method and power method, electron diffraction patterns, study of structure of materials – determination of accurate lattice parameters. Phonons and lattices vibration. Defects in cryalline solids. Dislocations. Crystal growth.

PHY 815 Basic Model Concepts And Manifest Properties Of Solid (3 Credit Units)
Properties of Energy Bands in Solids: Wave function for an electron in a periodic potential, energy bands in a perturbed nearly free electron systems. Energy band calculations, density of states in energy bands. Introduction to energy bands in solids. Optical processes in solids. Absorption and reflection phenomena. Carrier recombination and luminescence, direct and indirect transitions. Excitations, colour centres and lasers. Photoelectric phenomena.

PHY 816 Semi-Conductor Physics (3 Credit Units)
General introduction: Energy bands, free and localized levels scattering Electronic transitions, recombination, trapping lifetime. Maxwellian distribution function Boltzmann's equation, continuity ad conductivity equation. Carrier injection into semiconductors. Ambipolar flow, "field-free" diffusion. Current flows in semiconductors: contacts blocking and injecting. p-n junction. Application to device technology.

PHY 817 Physics Of The Earth's Interior (3 Credit Units)
The composition of the earth. The physical characteristics of earth's material; material, electrical and magnetic properties. Earth's and interior. Further evidence from seismology, geothermal state and geomagnetism. Geodynamics-Global picture of the dynamic earth. Plate theory and rheology

of the earth's interior. Evidence from geomagnetic reversals. Mechanism of earthquake and the new global tectonics. Field and laboratory investigations especially high pressure geophysics.

Elective Courses for Radiation and Health Physics/Nuclear Physics

PHY 818 Fundamentals Of Nuclear Physics (3 Credit Units)
Introduction and basic concepts: Definitions, Nuclear properties, Nuclear potential and energy levels. Radioactivity and transformation kinematics. Nuclear collisions. Nuclear Instability: ?' decay, ?' decay, electron capture (EC), ?- decay and semi classical theory of ?-decay, gamma – decay and yield selection rules, Internal conversion (IC), Auger electron emission. Interaction of Radiation with matter: specific ionization, linear energy transfer (LET). Mechanisms and energy transfer of Heavy changed particles (Bethe-Bloch formula, Bragg curve, energy requirements etc), fast electrons, gamma-rays, neutrons including attenuation and moderation. Nuclear reactions: general feactures of nuclear reactions, elastic scattering, direct reaction, compound nucleus reaction. Heavy ions reaction. Brief review of concepts and principles of reactors and criticality.

PHY 819 Radiation Detection And Dosimetry (3 Credit Units)
Radiation quantities: Definitions and Units Radiation detection methods: ionization in gases; Ionization in semiconductors. Scintillation Gamman spectrometry. Neutron detection. Thermoluminescence. Film Dosimetry, Chemical dosimeter (Fricke). Particle Track detection, calorimetry, etc. counting statistics Dosimetry: External dosimetry (gamma). Internal dosimetry. Reference Man Patient Dosimetry in radiographic examination, mammography, fluoroscopy and computed tomoeraphy.

PHY 820 Radiation Protection Guides (3 Credit Units)
The External Radiation Hazard and Protection: Time, distance and shielding, Monitoring for external radiations (areas and personal). The Internal Radiation Hazard and Protection: Sources and type of airborne contaminants, control of the internal radiation hazard, exposure reduction, internal dosimetry. Waste Management : Contamination, protection against contamination (protective clothing, decontamination). Waste disposal, packaging and safe transport of radioactive materials. Principles of Radiation Protection Justification, optimization, dose limit, international safety standards – ICRP, BSS, NNRA Elements of Radiation Protection Programmed in Medicine and Industry: Monitoring, Emergency preparedness planning and response. QA and QC for equipment. Training, Audit, Safety of equipment.

PHY 821 Nuclear Application In Medicine, Industry And Research (3 Credit Units)
Physics and Principles of diagnostic imaging equipment: radiographic unit, computed tomography, mammographic units. Principles of radiation therapy (teletherapy and brachytherapy). Physics of radiotherapy equipment; CO-60 unit and Linear accelerator. Physics and operational principles of Gamma camera. Physics of positron (?') Emission Tomography PET). Physics and operational principles of Magnetic Resonance Imaging (MRI). Industrial Uses: Industrial radiography, Tracing, Gauging. Material Modification. Sterilization food preservation and others. Research Uses. Neutron Activation Analysis. Particle-induced N-ray Emission PIXE and others.

PHY 822 Non-Ionizing Radiation (3 Credit Units)
Radiometric Units Lasers: Laser operations. Lasing Actions. TEM modes, Biological effects: eye damage, skin damage Protection Guides and Standards, Maximum Permissible Exposure (MPE). Safety Measurements, power and energy. Beam divergence Radiofrequency (RF) and Microwave: Communications, antennas and antenna gain. G. Penetration depth GSM land-sets and base stations. Biological Effects. Thermal and Non Thermal Effects, temperature-humidity index microwave Measurements, survey meters. Protection Guides and Standard Maximum permissible exposure (MPE) Safety.

Elective Courses for Theoretical Physics

PHY 823 Themodynamics And Statistical Mechanics (3 Credit Units)
Basic Postulates of thermodynamics of simple, homogeneous systems. Thermodynamic potentials and stability of thermodynamic systems. Gibb's theory of thermodynamics with interaction effects. Partition functions of difference ensembles. Fundamental equilibrium theory; liouville's theorem and the Ergodic hypothesis. Distribution Functions, entropy and connections with thermodynamics. Microcanonical, canonical and grand canonical ensembles. Boltzmann and Maxwell Bolizmann distribution phases and transitions; phenomenology of phase equilibria; First and second order transitions. Applications to classical and quantum systems. Boltzmann equation. Einstein transition probability. Random variables. Brownian motion and their applications. University and scaling Critical indices.

PHY 824 Quantum Field Theory (3 Credit Units)
Interactions of a point particle. Symmetries and conservation laws, fundamental invariants, energy-momentum tensor. Neother's theorem. Green's functions. Radiations. Relativistic Wave equations: the klein-Gordon equation. Dirac equation and the Weyl equation. Dirac propagator. Quantization of fields: scalar field charged scalar field, quantized radiation field, massive vector fields. Interaction with external fields: emission probabilities. Compton effect, Pair creation and annihilation, Bremmstrahlung etc. perturbation theory. Feynmann rules. Feynmann diagrams. Radiative corrections and renormalization: vacuum corrections, electron propagator, vertx functions, the Lamb shift, the anomalous magnetic moment. Functional methods. Introduction to Gauge Field theories.

PHY 825 General Ralativity (3 Credit Units)
Generalization of special relativity. Effects of gravity, curved spacctimes, metrics, particle paths as geodesics, light and null geodesics. Curved spacctimes: Tensors as a general tool in curved spacetimes: Tensors as general tool in curved spacctime, geodesic equations, curvature and its description. Geodesic deviation. Distributed matter and the stress-energy tensor. Emstein equations in general and in vacuum. Lambda term. Spherically symmetric vacuum solution: Schwarzschild metric, equation of motion in the Schwarzschild metric equation of motion in Schwarzschild metric. Properties of the orbits of particles of the orbits of particles and photos. Infall into a black hole. Eveny horizon and infinite redshift surfaces. Weak-field limits: Gravitational lenses, time delays and periastron advance. Binary pulsa. Gravitational collapse. Rotating black holes. The Kerr metric. Its singularities and horizons, properties particles and photon orbits, inertial frame dragging.

PHY 826 Particle Physics (3 Credit Units)
The Standard Model: Elementary particles (quarks, leptons, antiparticles and hadrons). Forces of nature (electromagnetic, strong, weak, gravity), Gange Bososns (photons, gluons, W+ and Zo, graviton). Strength and range of interactions. Theoretical framework. Natural limits. Four vectors. Electromagnetic Interaction: QED. Feynman diagrams. Vertices. Perturbation theory. Renormalization. Weak Interactions: Charged currents. Parity violations. Weak interaction of laptons and quarks. Neutral currents. Electroweak unification and the Glasshow-Weinberg-Salam model. W+ and Zo bosons. Precision tests of the standard models in e+e-. Strong Interaction: QCD. Gluons and colour. Properties of QCD (quarks confinement, asymptotic freedom and hadrons). Strong interaction vertices. Running coupling constants. Quark model of hadrons: light quark meson. Baryons: Mesons, masses and magnetic moments. Hardron resonances. The c and b-quarks. Beyond the Standard Model: the Higgs bosom, Neutrino oscillations. Grand Unification (proton decay). Supersymmetry.

PHY 827 Non-Linear Dynamical Systems (3 Credit Units)
Types of non-linear dynamical systems and connections between them. Poincare sections, conjugacy and flow equivalence. Review of portraits and the geometry of solutions to ordinary differential equations. Stability: Liapunow, quasi-asymptotic stability. Liapunov functions. Liapunov stability theorems and linera: stability (for distinct eigenvalues). Stationary points in R2.

Population models as examples. Periodic orbits in ordinary diffentrial equations. Statement and explanation of Poincare-Benedixson theorem. Poincare index and Dulas criterion. Bifurcation theory (by Taylor's series) and Hopf bifurcation. Maps of the interval. Fixed points, periodic points and stability. Staddle-mode and periodic doubling bifurcations. Chaos: Piecewise linear maps; the tent map; the tent map. Transivity and chaos (sensitive dependence on initial conditions). Brief description of the maps $x - nx(1 - x)$, particularly for $n=4$, and topological conjugacy. Period three implies existence of all periods. Statement of Sharkovskii theorem.

*** New courses in other specialisations can be added to this list.**

14 STATISTICS

The Master's degree in Statistics is intended to equip the student for a career as an applied statistician working in government, industry, research organizations, engineering and consulting firms, health care organizations, public utilities, and so on.

Generic Compulsory Courses In Statistics

SCI 801	Management and Entrepreneurship	(2 Credit Units)
SCI 802	ICT and Research Methodology	(2 Credit Units)
STA 800	Research Project	(6 Credit Units)
STA 801	Statistical Inference	(3 Credit Units)
STA 802	Probability Theory 1	(3 Credit Units)
STA 803	Design and Analysis of Experiments	(3 Credit Units)
STA 804	Categorical Data Analysis	(3 Credit Units)
STA 805	Sample Survey Techniques	(3 Credit Units)
STA 817	Seminar	(2 Credit Units)

Elective Courses

STA 806	Statistical Computing/Consulting	(3 Credit Units)
STA 807	Non-parametric and Sequential Methods	(3 Credit Units)
STA 808	Bayesian Inference	(3 Credit Units)
STA 809	Multivariate Analysis	(3 Credit Units)
STA 810	Time Series	(3 Credit Units)
STA 811	Stochastic Processes	(3 Credit Units)
STA 812	Advanced Statistical Theory	(3 Credit Units)
STA 813	Quality Control and Practice	(3 Credit Units)
STA 814	Econometrics	(3 Credit Units)
STA 815	Biostatistics	(3 Credit Units)
STA 816	Probability Theory 11	(3 Credit Units)

STA 801 Statistical Inference I (3 Credit Units)

Conditioning, distribution theory, approximation to distributions, modes of convergence, limit theorems, statistical models, parameter estimation, properties of estimators, confidence sets, theory of hypothesis tests, introduction to Bayesian inference and nonparametric estimation.

STA 802 Probability Theory I. (3 Credit Units)

Introduction to measure theoretic probability; derivation and transformation of probability distributions; generating functions and characteristic functions; conditional expectation, sufficiency, and unbiased estimation; methods of large sample theory including laws of large numbers and central limit theorems; order statistics.

STA 803 Design And Analysis Of Experiments (3 Credit Units).

General Linear Models; Generalized inverse of a Matrix, Factorial Experiments; Symmetric and Asymmetric; Balanced and Partially Balanced incomplete Block Designs. Resolvable, Row-Column designs. Response Surface Methodology. Construction of Designs.

STA 804 Categorical Data Analysis (3 Credit Units).

Probability mass functions for 2x2 tables measures of association for 2x2 tables and general cxc tables. Probability mass functions for rxc tables. Goodness of fit tests. Square tables and their applications structural models for two and higher dimensions; Log-linear models and estimate of parameters. Logistic regression and bio-assays.

STA 805 Sample Survey Techniques (3 Credit Units)
Construction and choice of strata, frames and various equal and unequal probability sampling schemes with properties. Estimation of means, proportion and their variances. Successive sampling scheme. Problems of non-sampling error and non-response: application to some selected specialized survey.

STA 806 Statistical Computing/Consulting (3 Credit Units)
The design and use of existing statistical software; methods of simulation of random processes; numerical methods of fitting linear models, multivariate analysis; methods for nonlinear modeling. Introduction of key aspects of statistical consulting and data analysis activities, report writing and presentation.

STA 807 Non-Parametric And Sequential Methods (3 Credit Units).
Distribution-free methods. Distribution of order statistics and quintiles. One and two sample tests. Confidence intervals. Transformation of statistics and their asyptotic properties. OC and ASN functions of SPRT. SPRT for composite hypotheses Elements of sequential estimation stein's two stage sampling methods for point and interval estimate.

Elective Courses

STA 808 Bayesian Inference I. (3credit Units)
Sampling theory and its critique, subjective probability, likelihood principles, Bayes theorem, Bayesian analysis of Normal theory inference problems, the Behrens-Fisher problem, assessment of model assumptions, robustness of inference, analysis of variance, estimation of variance components, empirical Bayes, some aspects of multivariate problems, sequential nature of Bayesian inference, prior and posterior distributions of parameters in binomial, poisson, exponential and normal populations, comparison of two normal distributions, predictive distributions, decision theory, utility, risk aversion, extensive form of analysis, two-action problems, point estimation, best population problems, economics of sampling.

STA 809 Multivariate Analysis (3 Credit Units)
Multivariate normal distribution, estimation of mean and covariance matrix; Wishart distribution; distribution of partial and multiple correlation coefficients; Hotelling's T^2, Principal components.

STA 810 Time Series And Application (3credit Units)
Theory of stochastic models and their forecasting. Model building: identification, estimation. Diagnostic checking. Analysis of stationary Data Co-integration and error correction techniques.

STA 811 Stochastic Processes (3 Credit Units)
Classification of stochastic processes. Random walk models, markov chains, inventory model, branching processes. Poisson, birth-and-death processes. Waiting time models, Estimation problems.

STA 812 Advanced Statistical Theory (3 Credit Units)
Limiting theorems. Convergence of sequence of variables and some probability functions limiting distribution. Generating functions and inversion theorems. Special parametric univariate and multivariate distributions and large sample theory. Further theory of statistical inference.

STA 813 Quality Control And Practice (3 Credit Units)
Analysis and control of variations in a production process OC of a control chart. Control charts for attributes and variables. Cumulative sum control charts. Other contrl charts. Methods of

controlling several related characteristics; Process capability analysis. Design of control charts. Specification and Tolerance.

STA 814 Econometrics (3 Credit Units)

OLS, Gauss- MarkoV Theorem. MLE. Specification and misspecification test. Predictive and non-predictive tests, Tests of hypothesis for linear model. The likelihood ratio, wald and language multiplier Tests; Multi-collinearity. Specification bias. GLS. Dummy variables and seasonal variations. Inferences based on asymptotic Distribution Theory.

STA 815 Biostatistics (3 Credit Units)

Advanced Regression, Bio-assays, Probit and Logit models, Growth Curves; Logistic Regression, Potency/efficacy determination. Theory of clinical trials, Ethical Issues in Medical Data Collection.

STA 816 Probabilty And Distribution Theory (3 Credit Units)

Sample space, algebra of sets and events, axiomatic definition of probability and independence. Bayes theorem, Random variables and their distributions. Moment, Cummulant and Probability Generating functions, Some special distributions and their properties. Multivariate continuous distribution: Marginal and Conditional Distribution. Distribution functions of random variables and some derived distributions Limiting theorems and limiting distributions. Elements of stochastic processes.

Areas of Specialization

i Sampling Theory
ii Design and Analysis of Experiments
iii Categorical Data Analysis
iv Biostatistics
v Quality Control
vi Multivariate Analysis
vii Mathematical Statistics
viii Econometrics
ix Time Series
x Operations Research

15 ZOOLOGY

15.1 General Courses

SCI-801 Management And Entrepreneurship (2 Credit Units)
The course will cover business environment, general management, financial management, entrepreneurship development, feasibility studies, marketing and managerial problem solving.

SCI-802 ICT And Research Methodology (2 Credit Units)
This course should cover essentials of Spreadsheets, Internet technology, Statistical Packages, Precision and accuracy of estimates, Principles of scientific research, Concepts of Hypothesis formulation and testing, Organization of Research and Report Writing.

15.2 Areas Of Specialization

Areas of specialization in Zoology are:-
Ecology and Environmental Biology Entomology Fisheries and Hydrobiology Parasitology Animal Physiology

Core Courses applicable to all Options:-

ZOO 801 Research Techniques/ Methods In Zoology (2 Credit Units)
These include methods and techniques needed in planning and conducting research in Environmental Biology, Entomology, Fisheries and Hydrobiology and Parasitology. These techniques should reflect the specific needs of the respective specializations.

ZOO 802 Bioinformatics (3 Credit Units)
Scripting. Use of computer programmes. Programme installation and navigation. Data mining. Statistical analysis. Primer design. Sequence analysis. BLAST. Phylogenetic analysis. Protein alignment.

ZOO 803 Seminar (Current Topics) (2 Credit Units)
This involves a critical review of current literature in specific areas of specialization. Each student is expected to write and make an oral presentation on a topic in his/her area of specialization and must participate in all departmental seminars.

ZOO 804 Research Project (6 Credit Units)
A research project in the relevant area of specialization which must be defended before a panel of external and internal examiners.

Ecology And Environmental Biology

ZOO 805 Ecotoxicology (3 Credit Units)
Sources of exposure to toxins. Natural and man-made toxins. Toxins in the Nigerian environment. Bioassay for ecotoxins. Resistance and evaluation of toxicity. Radiation biology.

ZOO 806 Ecology of Tropical Ecosystems (3 Credit Units)
Intensive studies of the factors affecting the abundance and distribution of animals in tropical terrestrial ecosystems (lowland forests, savanna, deserts and montane systems). Community structure, functions and dynamics. Adaptation of animals to different tropical environments and the effect of human activities on tropical ecosystems. Ecology of coastal and tropical inland waters like estuaries, lagoons, rivers, natural and artificial lakes. The inter-relationships of fauna and flora. Man's influences on the aquatic environment

ZOO 807 Wild life Conservation and Management (3 Credit Units)
Wildlife in relation to their environment. Factors affecting the distribution and abundance of wildlife. Inter-relationships between climate, soils, vegetation, history and wildlife populations. The wildlife resources of Nigeria. Movement, behaviour, life cycles, reproduction, food and food habits of wildlife. Natural and efficient usage of range lands in Africa. Methods of range assessment and management. Principles of biological conservation. Natural reserves.

ZOO 808 Environmental Impact Assessment (3 Credit Units)
Basic concepts, principles and history of Environmental Impact Assessment (EIA). Relationship between EIA and Environmental Impact Statement (EIS). Indicator species and organisms of value in environmental assessment. Essentials in EIA. Potential problems of EIA and their solutions. Cost benefits as a tool for environmental decision-making. Field case studies of impact assessment in Nigeria.

ZOO 809 Behavioural Ecology (3 Credit Units)
Advanced studies of the adaptive value of social organization, territory, reproductive ecology, feeding ecology, predator/prey interactions and competition. Case studies.

ZOO 810 Ecology and Management of Tropical Wetlands (3 Credit Units)
Definition of wetlands. Important terms associated with wetlands. Distribution of wetlands in Nigeria. Ecology of wetlands. Biology of wetland fauna. Values of wetlands. Field studies

Entomology

ZOO 811 Insect Taxonomy (3 Credit Units)
A study of advanced principles and methods of insect classification, construction and use of keys. Techniques for the collection and preservation of insects.

ZOO 812 Insect Ecology (3 Credit Units)
Insect populations and the effects of environmental factors- temperature, relative humidity, rainfall, wind, etc. The ecology of pest control, including biological control. Intra- and inter-specific competition and dispersal; prey-predator interaction and strategies. Life table and key factor studies in insect natural populations.

ZOO 813 Insect Physiology and Biochemistry (3 Credit Units)
Study of relevant aspects of the genetics, physiology and biochemistry of insects. Current techniques in insect physiology. The integument, digestion, excretion, water and temperature relations and ionic regulation; respiration, circulation, nutrition, metabolism and energetics. Reproduction, growth and development. Physiological properties of insect muscles. Nervous systems and sense organs. Insect haemolymph, hormones and pheromones. Integrated control of insect pests including the physiology of insecticide resistance.

ZOO 814 Stored Products Entomology (3 Credit Units)
Bio-taxonomy and ecology of insect pests of crops and stored products in the tropics, with particular emphasis on West Africa. Techniques for screening stored products for infestation. Prediction of pest outbreaks. The chemistry of pesticide action. Principles and techniques of pest control for arable crops, plantation crops and stored products.

ZOO 815 Medical and Veterinary Entomology (3 Credit Units)
A study of the biology, distribution, control and economic significance of arthropods of medical and veterinary importance in Nigeria and the West African sub-region. Control programmes of tsetse fly, mosquitoes, blackflies, etc.

ZOO 816 Management of Harmful Insects (3 Credit Units)
Biology of selected insects harmful to man and his activities. Methods of control and current practice of management of such pests. Theories of natural control of insect pests. The role of bird, fishes, amphibians, small mammals and other agents.

Fisheries and Hydrobiology/Marine Biology

ZOO 817 Biology of Fishes (3 Credit Units)
The taxonomy of major groups and the communities of selected tropical fishes. The place of fish in freshwater and marine communities. Food and feeding habits of fish species. Identification of gut contents. Age and growth determinations. Reproduction, breeding and life cycles. Prey-predator relationships. Population studies, recruitment and mortality. Fish migration, territorial behaviour and schooling.

ZOO 818 Limnology/Marine Biology (3 Credit Units)
Origin and diversity of freshwaters and marine waters. Physico-chemical parameters of the aquatic environment. Ecological features of rivers, streams, lakes, ponds, estruaries, lagoons, seas, natural and artificial lakes. Plankton and benthos. Allochthonous production of inland waters. Aquatic pollution and its effects.

ZOO 819 Tropical Aquaculture (3 Credit Units)
Dams and pond construction. Stocking and pond management. Cropping and marketing. Cage culture; raceways and closed circulation systems. Fish propagation, controlled natural and induced spawning. Hatchery organization and management. Feed formulation and evaluation. Culture of shell fishes.

ZOO 820 Fish and Fishing Technology (3 Credit Units)
Fish preservation and processing. Fish by-products. Assessment of fish quality. Fishing methods; evolution of fishing methods-Trawls, nets, gears and gear types; fish location gadgets.

ZOO 821 Aquatic Resources (3 Credit Units)
Dynamics of aquatic resources. Theoretical considerations of primary and secondary energy budgets. Factors affecting energy budgets.

ZOO 822 Environmental Impact Assessment (3 Credit Units)
Basic concepts, principles and history of Environmental Impact Assessment (EIA). Relationship between EIA and Environmental Impact Statement (EIS). Indicator species and organisms of value in environmental assessment. Essentials in EIA. Potential problems of EIA and their solutions. Cost benefits as a tool for environmental decision-making. Field case studies of impact assessment in Nigeria.

Parasitology

ZOO 823 Basic Principles and concepts in Parasitology (3 Credit Units)
Hetero-specific associations among animals. Types of parasitism, parasites and their hosts. The effects of parasitism on the parasite and host. Distribution of parasites in a host population. Factors influencing parasite density and distribution. Host-parasite specificity; the species problem and the evolution of parasitism in the animal kingdom.

ZOO 824 Transmission and diseases of Protozoan Parasites (3 Credit Units)
Parasitic Protozoa of medical and veterinary importance. Transmission patterns and types of diseases caused by protozoan parasites in the tropics. The role of vectors in the transmission of protozoan diseases. The role of host behaviour in the transmission of protozoan parasites.

ZOO 825 Physiology and Biochemistry of Parasites (3 Credit Units)
Habitat and physicochemical requirements, nutrition, absorption, energy stores, energy metabolism in parasitic protozoa and helminths. Purine and pyrimidine biosynthesis, amino acid metabolism and membrane biology in parasitic protozoa and helminths. Moulting, arrested development, self cure phenomena. Parasitic adaptations and propagation of parasites. Ultra-structure of parasites and its relationship to physiological processes.

ZOO 826 Parasite Immunology (3 Credit Units)
Basic concepts; natural and acquired immunity. Cell types in immune systems; immunity to parasites (Protozoa and Helminths). Evasion of host immune response; Advances in immunization against parasitic infections. Immunological methods.

ZOO 827 Transmission and Diseases of Helminth Parasites (3 Credit Units)
Helminth parasites of medical and veterinary importance, including life history of parasites. Food and vector-borne parasitic infections. Type of diseases caused by helminth parasites. The role of host behaviour in parasitic helminth transmission. Circadian rhythms in the transmission of helminth parasites (filarial periodicity). Control strategies.

ZOO 828 Epidemiology and control of parasitic diseases in the tropics (3 Credit Units)
Introduction to the principles and methods of epidemiology. Types of epidemiological surveys (Descriptive, experimental and analytical). Patterns of disease occurrence in the tropics. Measurement of parasitic infections in a host population. Epidemiology and recent developments in the control of major parasitic diseases and their vectors in tropical Africa. Ethical consideration in epidemiological studies.